

ELECTRICAL REVIEW

FRIDAY
17 NOVEMBER 1961

WEEKLY
PRICE 1s 6d



BY APPOINTMENT
TO HER MAJESTY THE QUEEN
MANUFACTURERS OF ELECTRIC LAMPS
CROMPTON PARKINSON LTD

Crompton LIFE-LIGHT



No
other
lamp in
the world
has all these
features

LONG LIFE

RESISTANCE TO SHOCK

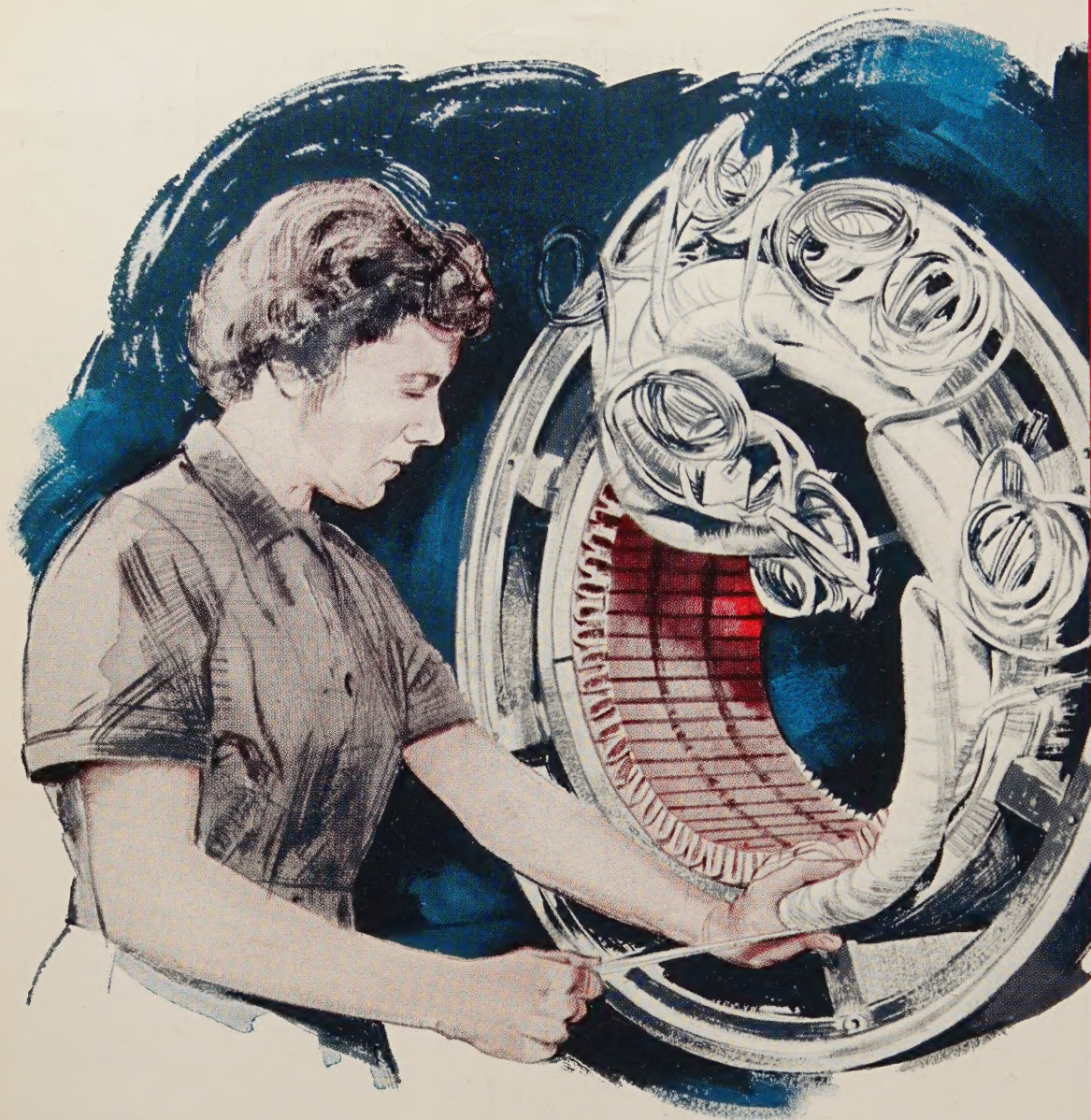
PATENT SHATTERPROOF FUSE

LOW CURRENT CONSUMPTION

FULL LIGHT OUTPUT

CAN BE USED IN ANY POSITION

- and you pay no more



The artist's impression shows the winding of a 150 h.p. electric motor stator with pre-formed coils at Brook Motors.

RTB Electrical Steel

LAMINATIONS of all types, in all sizes and in all grades of material.

FERROSIL hot-rolled and cold-reduced electrical sheet and strip, and hot-rolled transformer sheet.

ALPHASIL cold-reduced grain oriented transformer sheet and strip.

Richard Thomas & Baldwins Limited

RTB

Enquiries for sheet and strip to be addressed to RICHARD THOMAS & BALDWIN (SALES) LTD., WILDEN, STOURPORT-ON-SEVERN, WORCS.

Enquiries for laminations to be forwarded to RICHARD THOMAS & BALDWIN LTD., COOKLEY WORKS, BRIERLEY HILL, STAFFS.

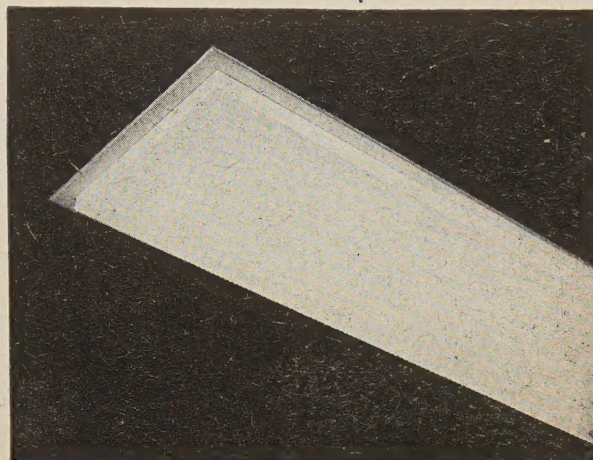


OFFICE LIGHTING NEEDS EXPERT TREATMENT

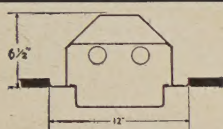
Good lighting is essential for every office—from the post room to the board room. The Lighting Specialists offer a comprehensive service backed by experience and expert knowledge, from the supply of a single fitting to the execution of a complete lighting installation.

I.E.S. CODE

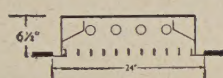
Our Lighting Design Service will be pleased to suggest individual and economical schemes which conform to the recommendations of the new Illuminating Engineering Society Code, covering minimum levels of illumination in conjunction with consideration of glare factors.



MODULES: 1' MODULE RANGE



SERIES: 2' MODULE RANGE



2' x 1'

5' x 1'

4' x 1'

6' x 1'

2' x 2'

4' x 2'

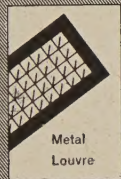
6' x 2'



Perspex Dish



Plastic Louvre



Metal Louvre



Glass Diffuser



Plane Prismatic Louvre

choose
a module..!

choose
an underside..!

...and you have
a range of elegant, practical
and efficient fluorescents.

B.Z. CLASSIFICATIONS

The B.Z. Classifications, enabling installations to be designed in accordance with the recommendations of the I.E.S. Code, have been completed for the wide range of standard fittings offered by Courtney Pope—The Lighting Specialists. Further information on request.



COURTNEY, POPE

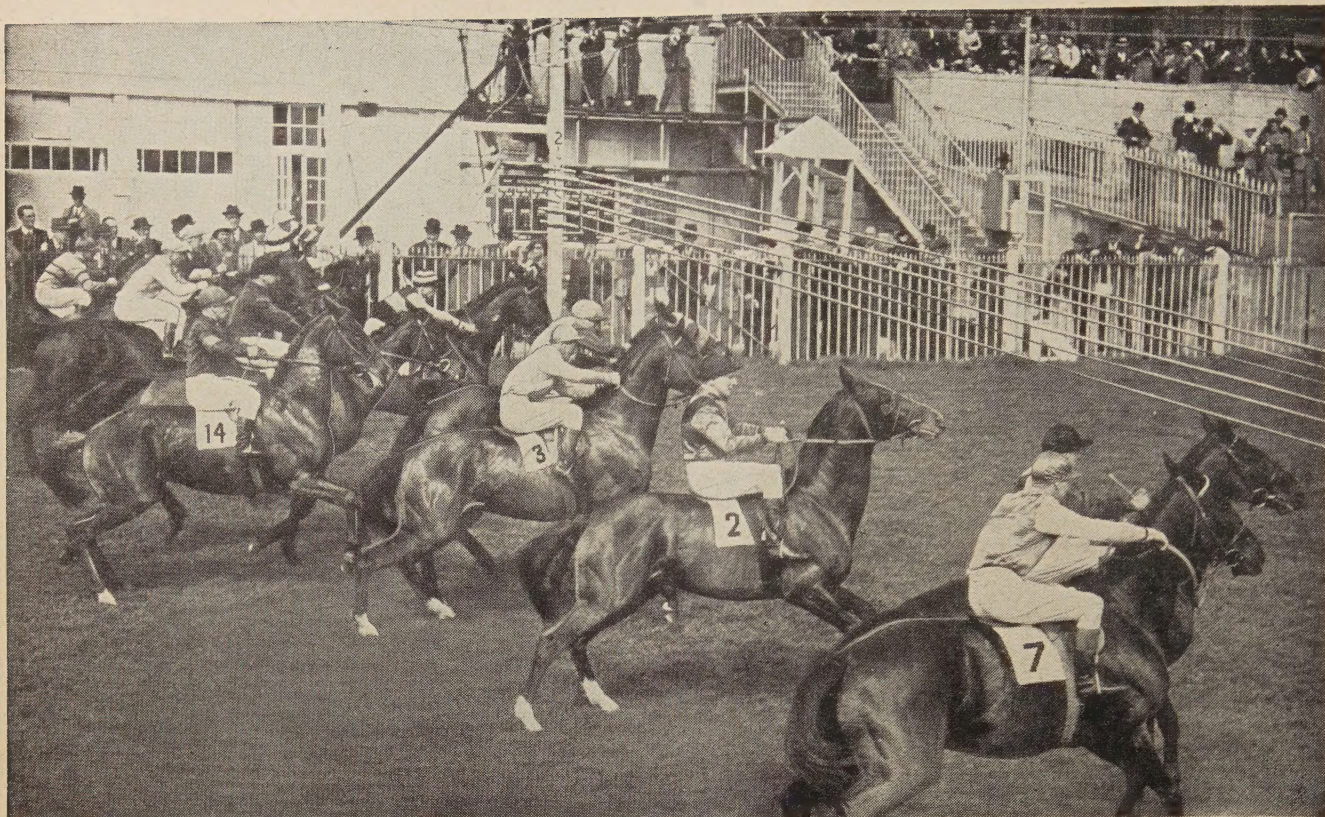
THE LIGHTING SPECIALISTS

COURTNEY POPE (ELECTRICAL) LTD.

AMHURST PARK WORKS · Tottenham London N.15
Telephone: STAmford Hill 1270 (fifteen lines)

BRANCHES:

4/10 Chatham Street, Manchester 1 (Central 1837)
Nechells House, Dartmouth Street, Birmingham 7 (Aston Cross 4541/2)
17 Wellington Street, Leeds 1 (Leeds 3-4549)



The choice is often difficult

May we pick the winner for you . . .

When choosing between Die Castings or Hot Pressings you can count on us for sound, unbiased advice. We make both **HOT PRESSINGS** in *Brass, Bronze, Copper or Aluminium*, and **GRAVITY DIE CASTINGS** in *Brass, Bronze or Aluminium*. The unique experience of our organisation . . . two separate yet inter-related operations under one roof . . . will ensure that your choice is correct.

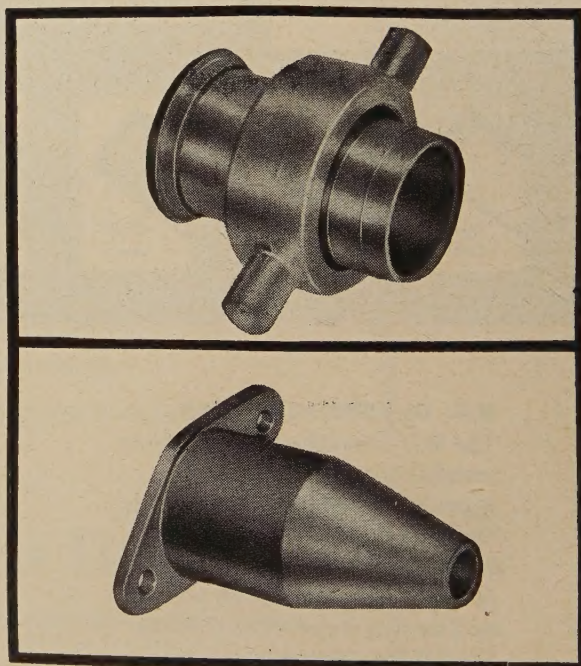
For a constant or phased supply of **DIMENSIONALLY ACCURATE PARTS** in *Brass, Bronze, Copper or Aluminium*—see us first! Our Technical Representatives are always at your service.

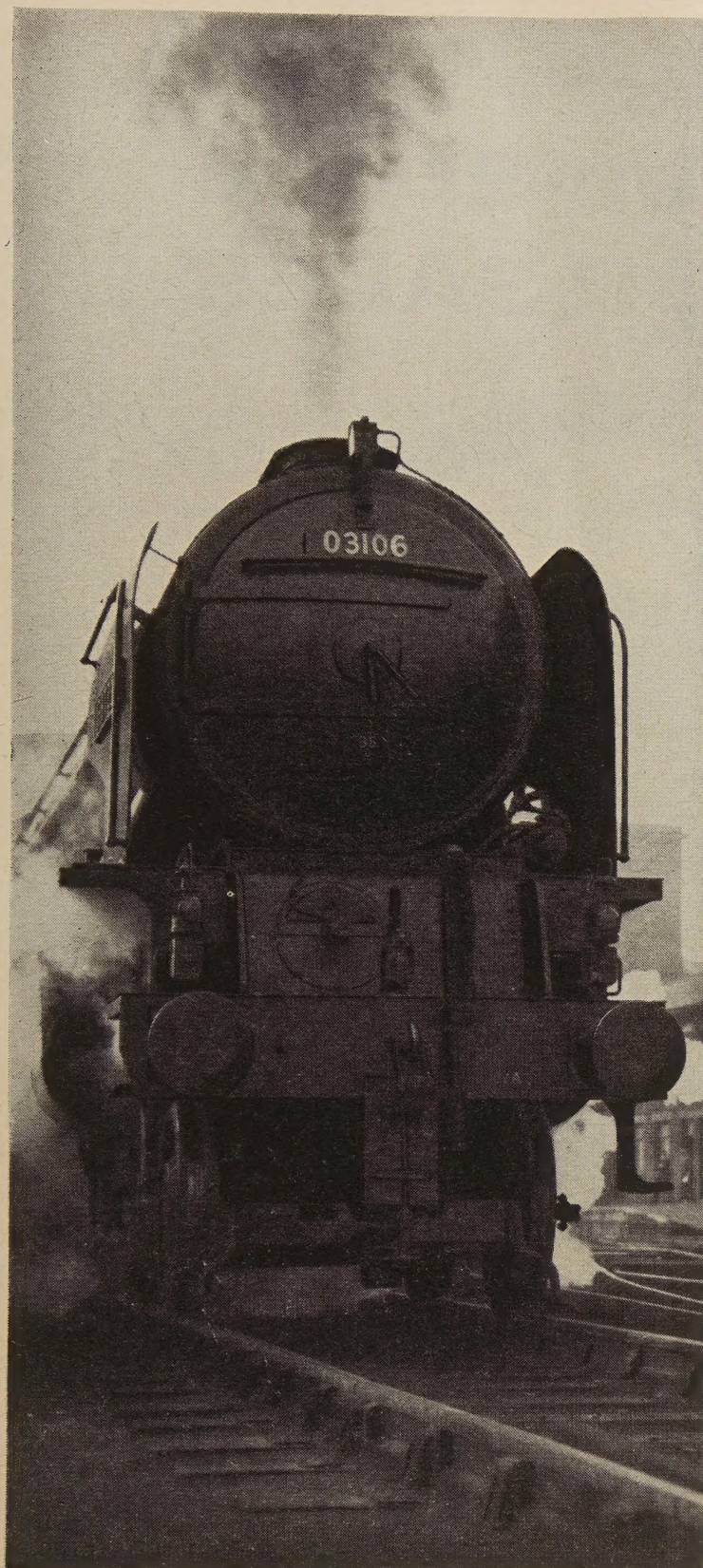
BRASS PRESSINGS (LONDON) LTD.
THE NON-FERROUS DIE CASTING CO. LTD.

NON-FERDICA WORKS, NORTH CIRCULAR ROAD, LONDON, N.W.2

Tel.: GLAdstone 6377

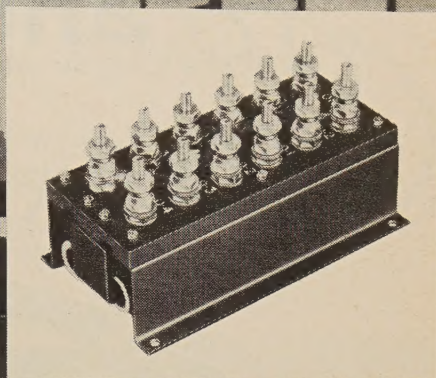
1732





Railways

ZENITH



Whether you are a commuter for steam, diesel or electric trains, the usual uneventful daily journey is only possible through the signalling system of British Railways.

Our larger inset picture illustrates a track feed installation at Finsbury Park, Eastern Region. The track circuit forms the basis of modern signalling. A current flows through the rails, insulated for this purpose, operating a normally energised relay. As a train enters the track circuited section its axles offer a better path, so the relay is de-energised and occupation of that section detected.

Tapped track circuit feed resistances regulate the current flow, and are adjusted to pass a current through the relay when that section of the track is unoccupied.

*CERAMITE wire wound, embedded resistors ensure complete reliability, having approval in Class H1.

We should be pleased to advise you on resistor matters and happy to send our catalogue.


*Registered Trade Mark

Photograph by courtesy of British Railways

**THE ZENITH ELECTRIC
COMPANY LIMITED**

**ZENITH WORKS • VILLIERS ROAD
WILLESDEN GREEN • LONDON N.W.2**

Telephone: WILLESDEN 6581/5 Telegrams: "VOLTAOHM, NORPHONE, LONDON"

 **For Top Speed
and TOP SALES...**

**THE SIREN
WHISTLING
KETTLE**



**...stock and sell
the range of
Swan Brand
FAST BOILING
Electric Kettles**

SWAN  BRAND

**ELECTRICAL APPLIANCES
AND GROUND BASE
ALUMINIUM HOLLOWARE**

Bulpitt & Sons Ltd., Birmingham 18,

Medium-size a.c. motors

FROM STOCK

IMMEDIATE DELIVERY

is offered of all the following foot-mounted induction motors.
The ratings listed are for 400/440 volt, 3-phase, 50-cycle supplies.

SQUIRREL CAGE (BS 2613)			
Screen-protected		Totally enclosed fan-cooled	
<i>h.p.</i>	<i>speed r.p.m.</i>	<i>h.p.</i>	<i>speed r.p.m.</i>
30	970	25	730
*55	720	†65	1475
70	720	†65	975
*75	970	†80	1465
100	725	†85	950
*125	1465	†100	1450
*130	970		
SLIPRING (BS 2613)		<i>*drip-proof enclosure</i> <i>† totally-enclosed closed air circuit motors, radiator cooled.</i>	
Screen-protected			
<i>h.p.</i>	<i>speed r.p.m.</i>		
30	965		
50	1450		

For further details of these and other AEI stock motor ranges, please contact your local AEI district office or Industrial Machines Dept., Mosley Road Works, Trafford Park, Manchester 17. Telephone No. Trafford Park 2431. Extension 1212.

AEI
Associated Electrical Industries Limited
Motor & Control Gear Division

RUGBY AND MANCHESTER, ENGLAND

Temperature control?



*Otters press their
contacts together
to open them
with a SNAP!*

Thermostats and Safety Cut Outs for the control and protection of:-

Convactor Heaters, Water Heaters, Fan Heaters, Washing Machines, Clothes Dryers, Hair Dryers, Electric Blankets, Electric Motors.

Otter thermostats are permanently and accurately set to give reliable temperature control.

The high contact pressure of all Otter thermostats ensures reliability even in bad conditions of dust and dirt.

OTTER CONTROLS LTD

OTTERS 'OLE, BUXTON, DERBYSHIRE. PHONE BUXTON 1745 (4 LINES)

WORLD PATENTS INCLUDING PATENT NUMBERS 600055, 622781, 624905, 657434, 713443, 749716, 774911, 782668 AND OTHERS. ALSO OTHER PATENTS PENDING.

MAXIMUM SUCTION

COMPACT DESIGN

EASILY MANOEUVRED

LOW CONSUMPTION

ROBUST CONSTRUCTION

UNIQUE CLEANING TOOLS

VERSATILE FACILITIES



Outstanding
IN EVERY WAY

All

STURTEVANT

INDUSTRIAL VACUUM CLEANERS

The high standards of design and manufacture which have established the superiority of Sturtevant cleaners ensure the easy application of these machines in all kinds of industrial conditions and to meet the most diverse cleaning requirements.

Available in many sizes and capacities they provide the only successful means of dealing with all types of settled dusts, dirt, litter, spillage, swarf and similar industrial refuse.

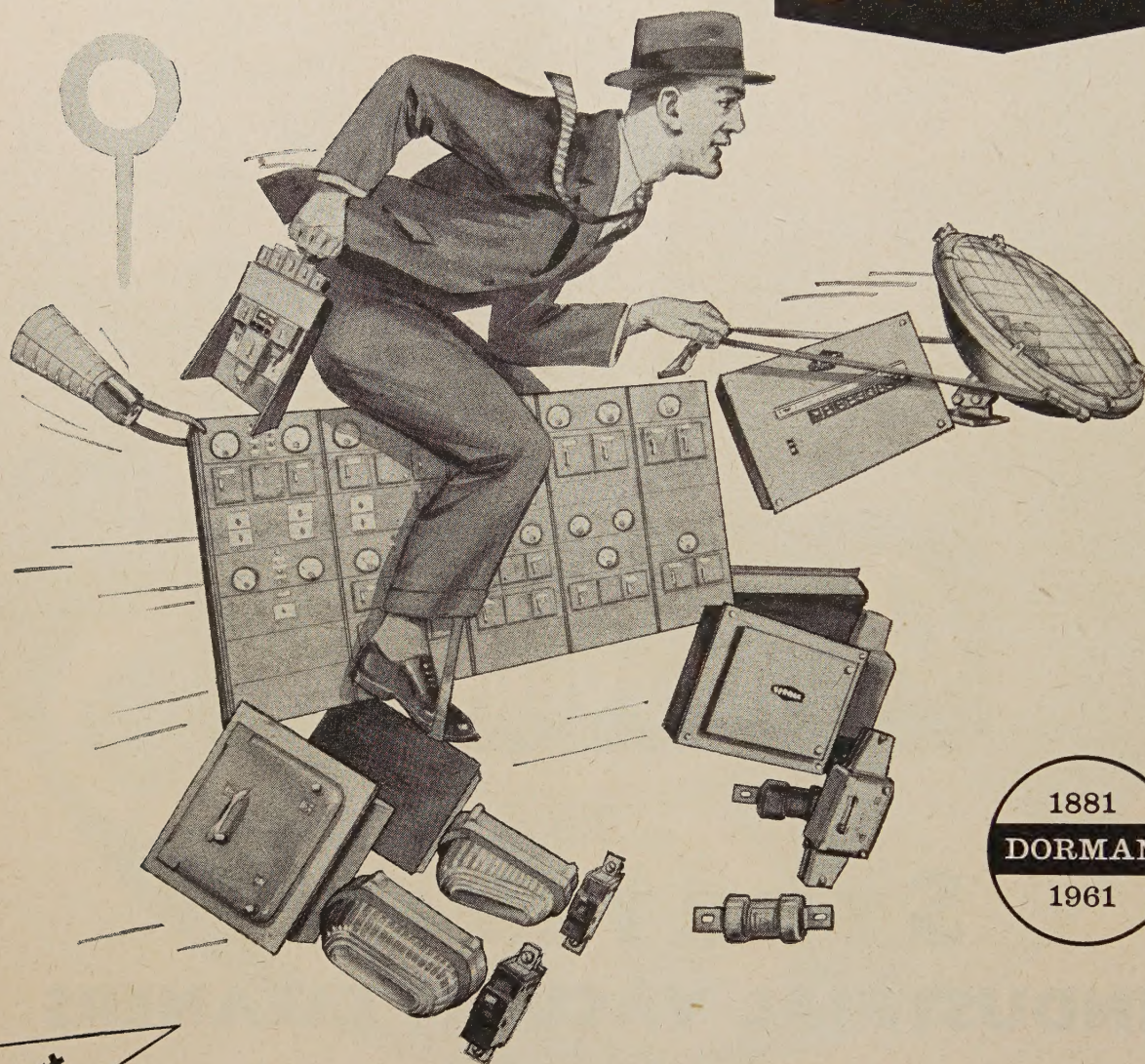
A typical Sturtevant machine is illustrated above. Details of this and other Sturtevant cleaners are given in our publication U5014/5

STURTEVANT ENGINEERING CO. LTD., SOUTHERN HOUSE, CANNON STREET, LONDON, E.C.4

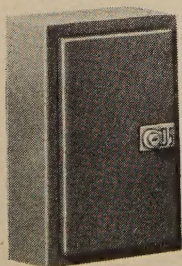
AUSTRALIA: STURTEVANT ENGINEERING CO. (AUSTRALASIA) LTD., MILLER ROAD, VILLAWOOD, N.S.W.

we've come up with

DORMAN



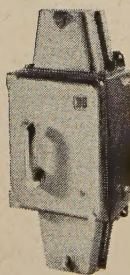
1881
DORMAN
1961



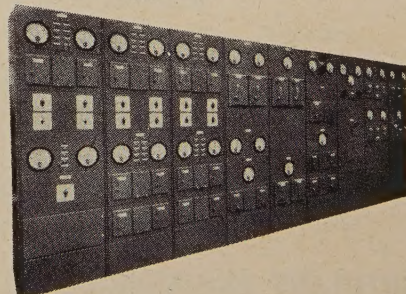
Distribution Fuseboards — industrial or 'Flowline' patterns; flush or surface mounting — for rewirable or H.R.C. fuse carriers.



Type 'Q' H.R.C. Cartridge fuse links. Subjected to stringent independent tests and conforming to B.S.88. Available up to 800 amp ratings.



Type T.S. Standardised Switches — front handle operation, compact design. Available in 30, 60, 150, 300, 500 and 750A ratings.



A typical nine-section cubicle switchboard, showing the adaptability and flexibility of the CUBICON system. Can be Dorman factory built or assembled on site from CUBICON standardised components.

some real winners in 80 years

FIRST IN THE FIELD WITH...

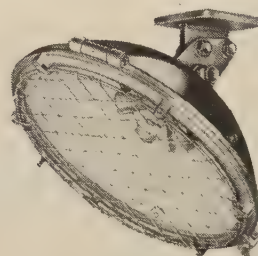
Lighting fittings—streamlined distribution boards—
unit-built metalclad switchboards—standardised
switchgear—build-it-yourself CUBICON
cubicle boards—miniature circuit breakers



A lighting fitting pioneered by us in the 1880s, incorporating the base loop lamp, the filament wires projecting through the bulb and hooked on to the spring terminals in the lampholder. Crude? yes; but it worked!



The tumbler switches shown above were in daily use at our Manchester factory, for over 60 years! Note the remarkable condition of the contacts, and the robust porcelain base. We were the first company in Britain to make tumbler switches, and the first to use porcelain as an insulator.



We designed the very first cargo cluster fitting in the world!—using an enamelled washbowl, white on the inside and blue on the outside. Illustration shows a fitting from our current range.

INVENTION HAS BEEN OUR MOST IMPORTANT PRODUCT...

AND QUALITY OUR WORKING PRINCIPLE

We are justly proud of our achievements since our beginning in 1881. The ubiquitous lampholder, now forming an essential part of every domestic or industrial installation, is a descendent from the original Dorman design. We pioneered the use of miniature circuit breakers in Britain and many parts of the Commonwealth. Another outstanding development of recent years is the Dorman System of standardised units for switchboard building, enabling elaborate switchboards to be built by the customer using components drawn from stock. Aware of our high reputation, Dorman are constantly engaged in producing new techniques and engineering talent to meet the challenge of the future.

DORMAN & SMITH LTD PRESTON, LANCS. Tel. PRESTON 86785 (6 lines)

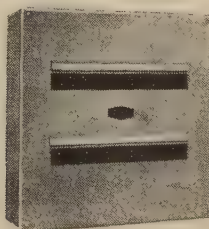
Branches, agents and stockists throughout the world



Metalclad switchboards, easy to plan—easy to build, using your own labour and normal hand tools only.



Loadmaster miniature circuit breakers from 5 to 60 amps rating, S.P., D.P., and T.P. Thermal/magnetic tripping. Ambient compensated. The lowest priced M.C.B.s. in Britain today.



Loadmaster Distribution Boards, 250/440v. A.C. S.P. & N., D.P. & N. T.P. & N., up to 16 ways, in five basic case sizes. The most comprehensive range available.

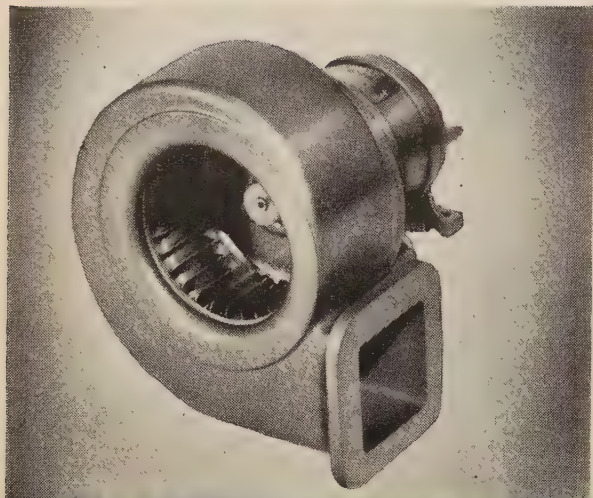


Examples from our current range of prismatic lighting fittings which include industrial, heavy duty, architectural, handlamps and cargo cluster patterns.

3 NEW BLOWER UNITS

FROM

PARVALUX



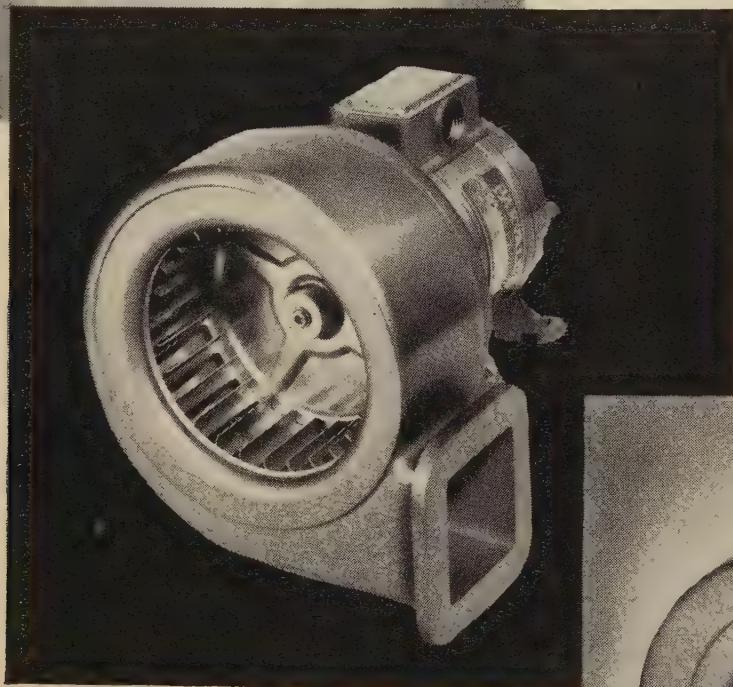
S.D.28

Totally enclosed
frames —

Class 'E' installation.

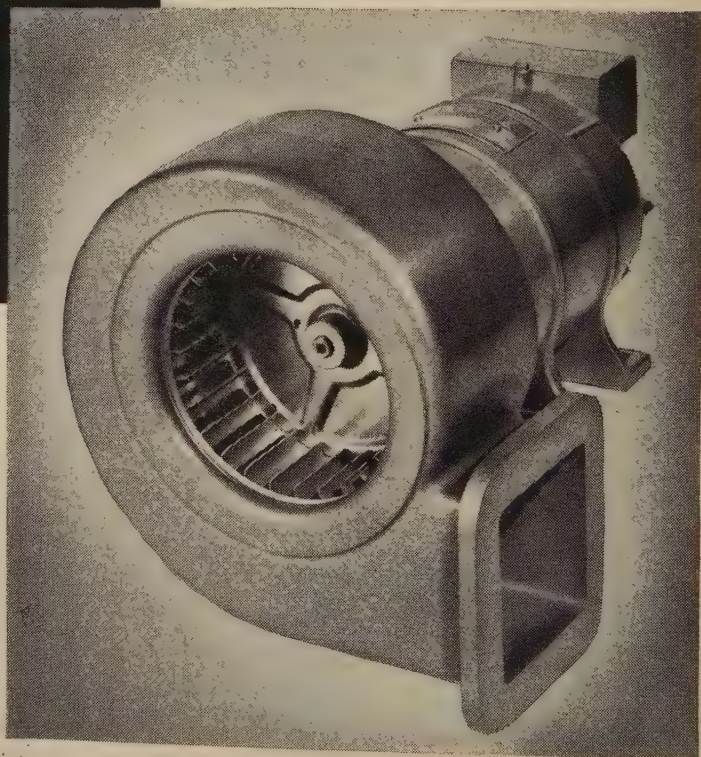
All standard voltages
built to B.S.S.

170 outputs up to
260 C.F.M.



S.D.27

S.D.26



REGISTERED TRADE MARK
PARVALUX

Fully illustrated literature from: Parvalux Electric Motors Limited, Wallisdown Road,
Bournemouth, Hampshire. Tel: Winton 4983/4 Grams: Parvalux, Bournemouth



Aluminium makes things cheaper to own

ELECTRICAL REVIEW 17 NOVEMBER 1961

11



These cables will be as good as new in A.D. 2011

These gangers and jointers are laying cables made with aluminium conductors. It's a sight that is becoming increasingly familiar in British cities, from London to Glasgow. It means power PLUS for homes, factories, offices and mines. The PLUS is Alcan aluminium in those conductors. They will still be carrying their load 50 years from now.

The gangers are installing 4 core $\cdot 3$ sq. in. low-voltage distribution cables. Aluminium is also increasingly used in high-voltage and extra-high-voltage feeders. It has great advantages for the sheathing of pressure-type cables. Jointing presents no problems.

Today, aluminium is the cheapest conductor material. Alcan production capacity and Alcan research make sure that it will hold its lead.

Cable manufacturers can give you further advice on aluminium cables. Write to them, or write to us :
Alcan (U.K.) Limited,
Aluminium Canada House,
30 Berkeley Square, London W.1.
Telephone : Mayfair 9721.



Britain's most widely used
aluminium — from Canada

ALCAN



Shell demonstration



To establish *facts* is the constant preoccupation of Shell research. Assumptions cut no ice.

For example, how 'extreme' is 'Extreme' Pressure?

To evaluate scientifically the respective performance of the many E.P. agents evolved, Shell devised the Four Ball Test machine illustrated.

In this apparatus a clamped $\frac{1}{8}$ " diameter steel ball revolves in contact with three identical static balls in a metal cup containing the additive to be tested. Pressure between the balls can be varied at will. Under these controlled rubbing conditions, coefficients of friction

can be plotted against load. With increasing loads, wear scars formed at successive stages may be measured and the welding point accurately determined. Developed for basic research, the Four Ball Test also plays an important workaday role in ensuring consistent batch quality—of prime importance on the machine-shop floor.

Thoughtful production executives who want to know more have only to write for the book, 'Selecting Your Cutting Oils', to Lubricants Dept., Shell-Mex House, London, W.C.2.

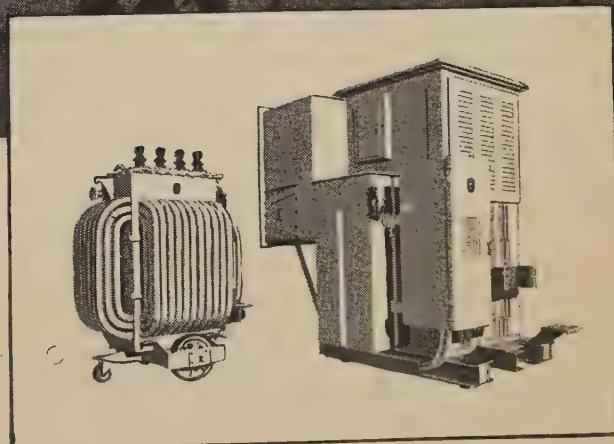


SHELL CUTTING OILS

BRENTFORD REGULATORS FOR C.E.G.B. LEATHERHEAD

To conduct experiments with heavy currents, the C.E.G.B. have recently installed in their laboratories at Leatherhead a number of Brentford Interstep Regulators. Each unit consists of a Regulating Auto Transformer which varies the voltage on the primary side of an associated Heavy Current Stepdown Transformer.

Technical Details These Brentford Regulators give stepless and on-load voltage adjustment. The equipment is rated to deliver 100,000 amperes at 0 to 20 volts or 50,000 amperes 0 to 40 volts. Maximum output is 2,000 kVA for 2 seconds every 5 minutes.

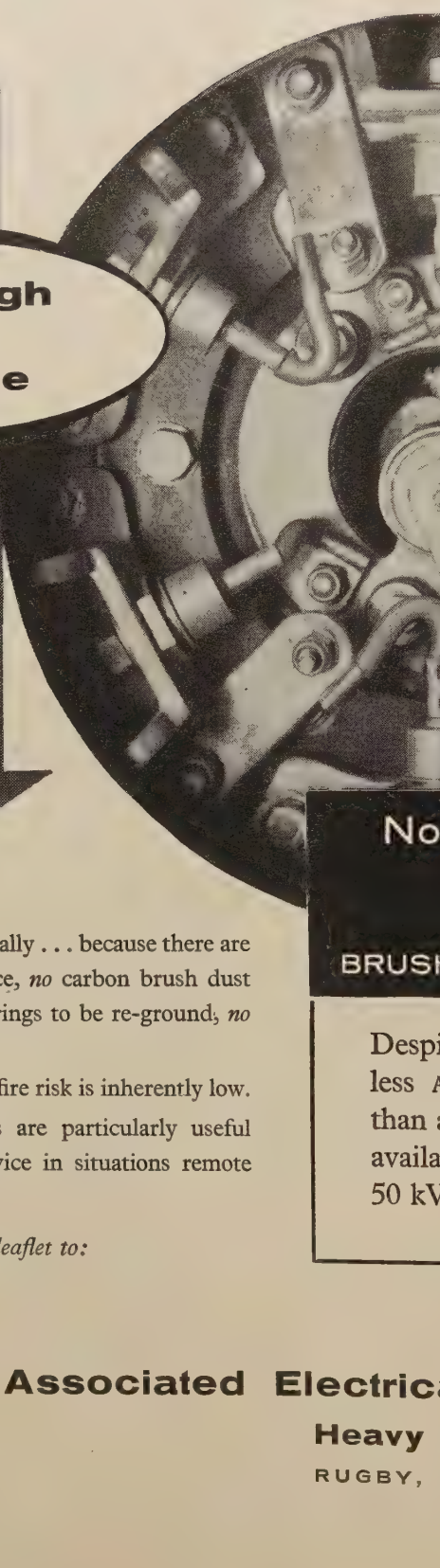


Brentford Transformers Limited, Manor Royal, Crawley, Sussex. Tel: Crawley 27755. A member of the GHP Group

BRENTFORD



The case for brushless is overwhelming!



**Just weigh
the
evidence**

Maintenance costs cut dramatically . . . because there are *no* brushes to inspect or replace, *no* carbon brush dust to endanger insulation, *no* sliprings to be re-ground, *no* commutator to be skimmed.

Because sparking cannot occur fire risk is inherently low. AEI brushless A.C. generators are particularly useful for standby duty and for service in situations remote from grid supplies.

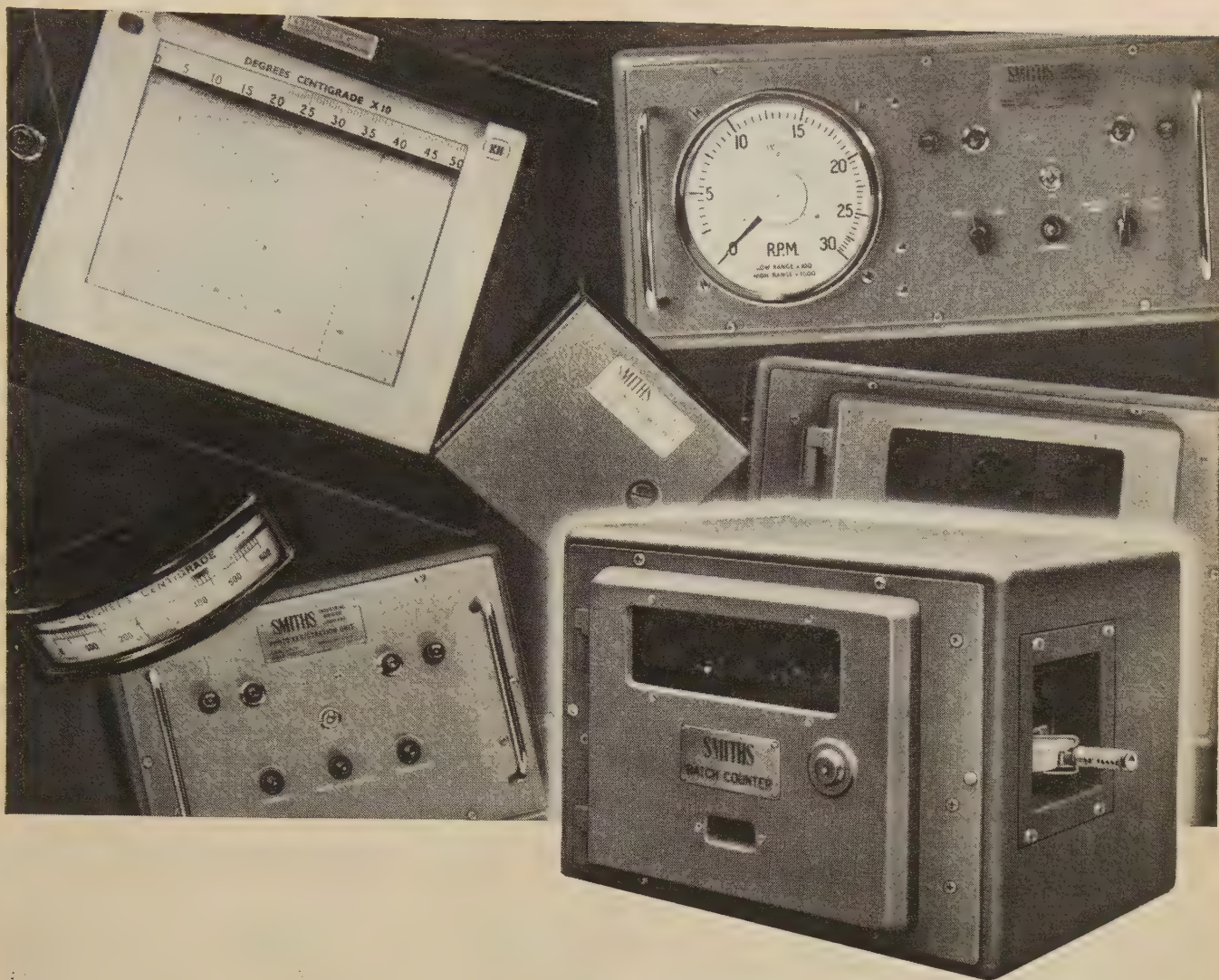
Write now for leaflet to:

**No wonder Industry
is installing
AEI
BRUSHLESS A.C. GENERATORS**

Despite all their advantages brushless A.C. generators cost no more than alternative equipment and are available in an extensive range from 50 kVA up to 5,000 kVA.

AEI

Associated Electrical Industries Limited
Heavy Plant Division
RUGBY, ENGLAND



electronically **SMITHS**

Systematically extending the application of electronics to industrial instrumentation, SMITHS Industrial Division can equip your plant for the counting and batching of units in large or small quantities, for the registration of continuously flowing material, for the highly accurate control of speed, temperature, current or voltage, and for many other functions. Inset above is SMITHS Standard Batch Counter, capable of counting batches up to a total of a million, from signals derived from magnetic, photo-electric or photo-transistor sensing heads. If you have an instrumentation problem, SMITHS are entirely at your service electronically. May we send a Technical Representative to see you?

SMITHS range of electronic instrumentation includes: Batch Counters; Frequency Meters; Photo-Registration Units; Calibrated Relays; Multi-channel Telemetry Systems; Data Handling Systems; Ultrasonic Flaw Detection Equipment.

SMITHS

INDUSTRIAL DIVISION

The Industrial Division of **S. Smith & Sons (England) Ltd**

Kelvin House Wembley Park Drive Wembley Middx. Wembley 8888



for
MICANITE
INSULATION

Consult

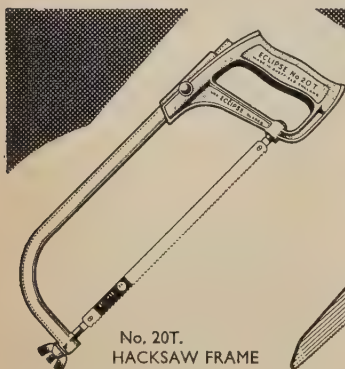
EAST LONDON MICA WORKS

RINGWOOD RD., WALTHAMSTOW, LONDON, E17

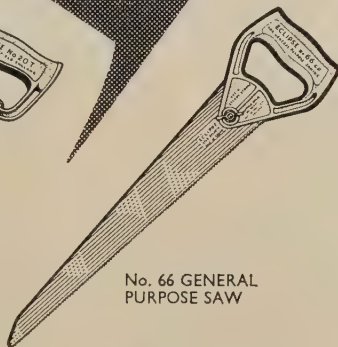
ESTD. 1912

Phone: COPpermill 2248/9

Telegrams: Elmicmer, Easphone, London



No. 20T.
HACKSAW FRAME



No. 66 GENERAL
PURPOSE SAW



No. 14J. JUNIOR SAW



PAD HANDLE



No. 4S. TOOL SET



tools for the
ELECTRICIAN



Made by James Neill & Co. (Sheffield) Ltd. and obtainable from your usual supplier

Tough, rugged, dependable Belmos flameproof switchgear was chosen by the Iraq Petroleum Company Limited for installation in a large tank farm in the Middle East where sun and sand combine to make the severest of operating conditions. It is not surprising that Belmos should be the choice of discerning engineers who know that over 40 years of experience, gained exclusively from the design, development, and manufacture of motor control gear, are "built-in" to every Belmos unit.



**IRAQ
PETROLEUM
CHOSE
BELMOS**



the Belmos company limited
BELLSHILL — LANARKSHIRE

Belmos

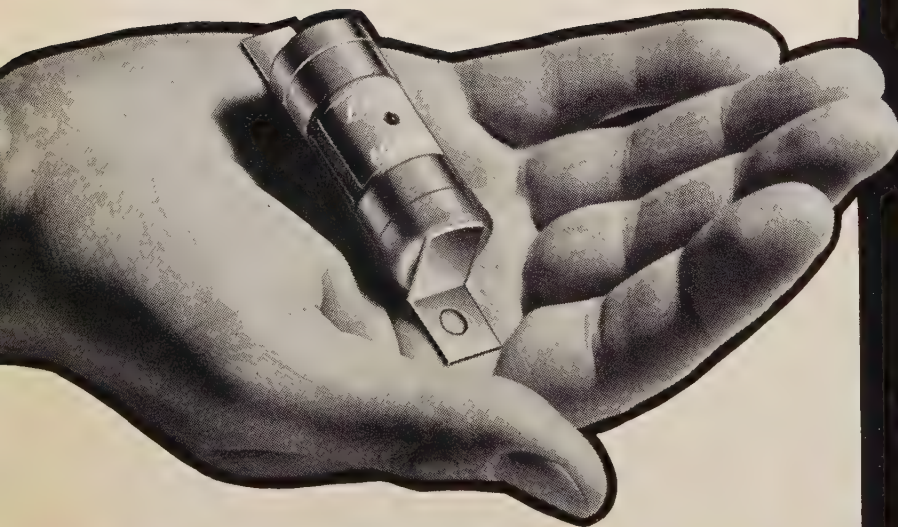
LONDON GLASGOW BIRMINGHAM NEWCASTLE MANCHESTER SHEFFIELD CARDIFF
PAM 405B

Aeroflex Brilag High
Breaking Capacity
Fuse-Links, certified to
BS 88 Cat. 440 AC5, in
30 amp to 400 amp
sizes. Dimensions as
recommended in BS 88.



Aeroflex

CARTRIDGE FUSE-LINKS



Aeroflex High Breaking
Capacity Fuse-Links
(Ferrule Type) certified to
BS 88 Cat. 440 AC5.
In 15 to 600 amp sizes.



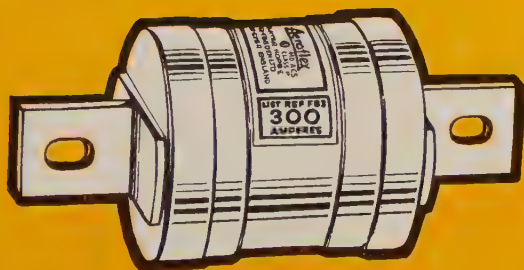
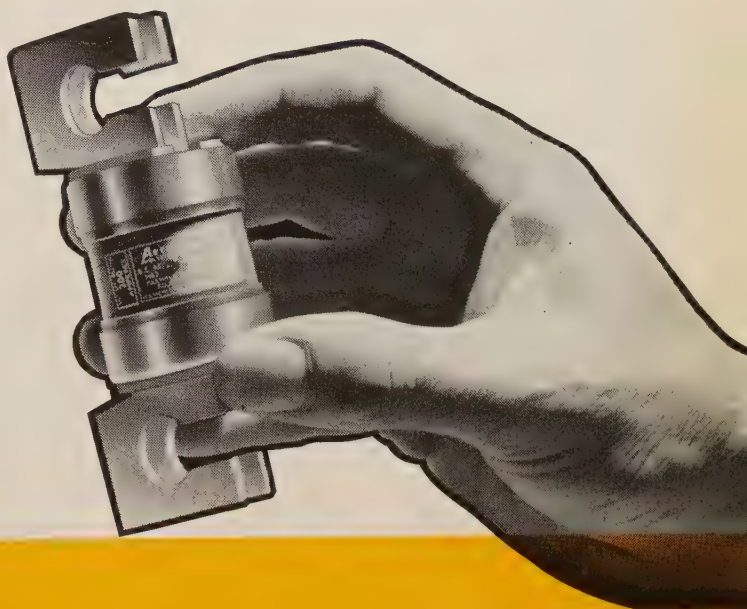


Aeroflex Q.C. Fuse-Links
with special characteristics
for the protection of
semi-conductor diodes.



Small parts — great performance

AEROFLEX High Breaking Capacity rewirable cartridge Fuse-Links transcend BS requirements and rigorous tests prove their performance to be without equal. Suitable for both industrial and supply applications, interchangeable with other leading makes, AEROFLEX have unique time lag and non-ageing characteristics and give the surest protection against overloading. You can **safely** say AEROFLEX,—the Fuse-Links for performances in a class of their own.



Aeroflex 'Brilag'
FB3 300 amp Fuse-Link.

You're more in hand with

Parmiter Hope & Sugden Ltd
FLUVENT ELECTRICAL WORKS · LONGSIGHT · MANCHESTER 12
London: 34 Victoria Street, S.W.1.
Glasgow: 5 Somerset Place, C.3.
Birmingham: 39/41 Carrs Lane, 4.





AEI WHAT WE
OWE YOU
IN THE WAY OF
EAGER BEAVER
SERVICE

The AEI Cable Division is a new entity. But it is not so new in other ways. It has men in it you know and trust—men you've done business with before. It has comprehensive stocks of **wiring cables and flexible cords**—located through a network of sales outlets all over the country. And it now offers the well-known Eager Beaver Service for these cables. Hard Work. Willingness. Resourcefulness. A whole team of Beavers anxious to assist you with your day-to-day wiring cable requirements. That's what the AEI Cable Division owes you, and it much looks forward to having an opportunity of discharging the debt.



CABLE DIVISION

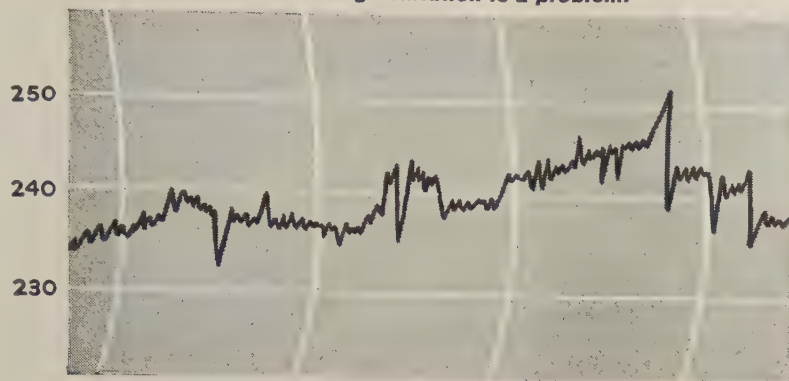
Associated Electrical Industries Limited

Cable Sales Department

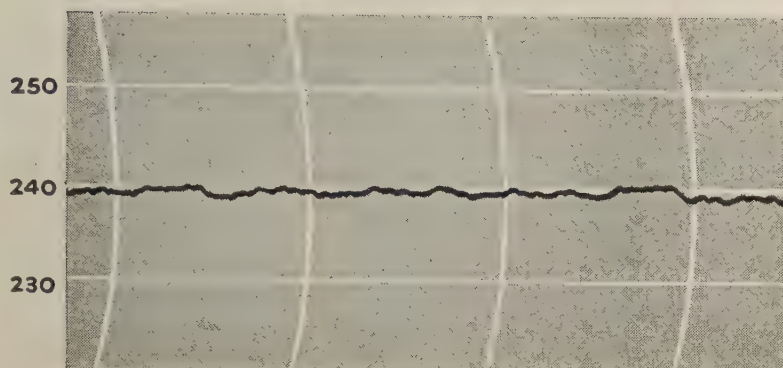
51/53 Hatton Garden · London · EC1 · Tel: CHAncery 6822



This recording is typical of line voltage conditions in an industrial establishment where voltage variation is a problem.

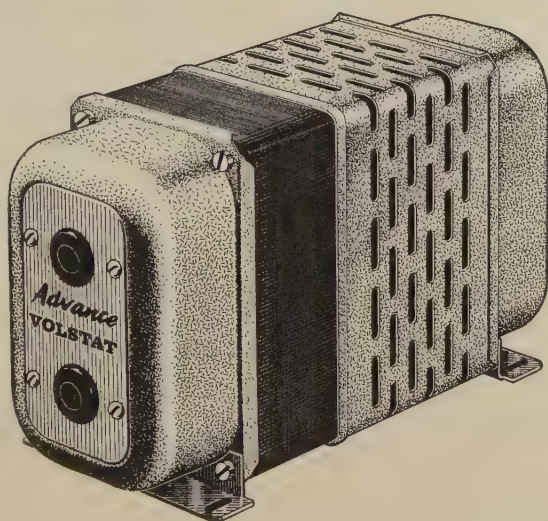


FLUCTUATING VOLTAGE

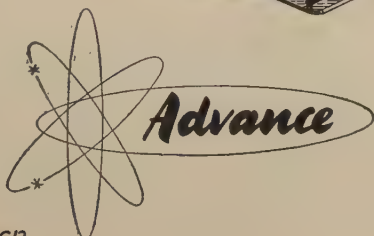


becomes constant with a

VOLSTAT

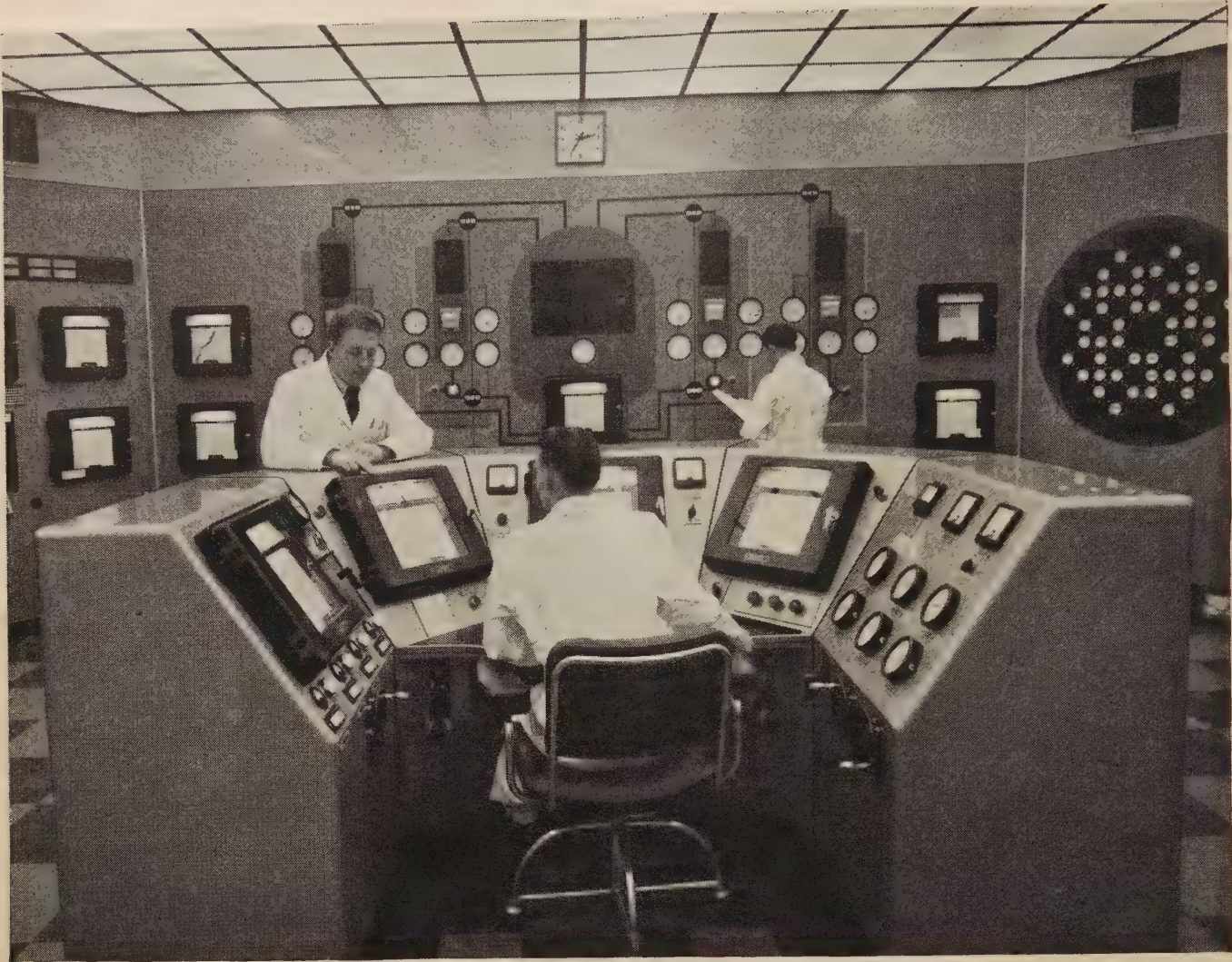


A VOLSTAT is the answer to many voltage fluctuation problems. In most cases, a standard type is all that is required—but there are occasions when a special design may be necessary. Either way, an 'Advance' Technical Representative will be pleased to investigate your own particular problems, and recommend a VOLSTAT best suited to your needs. VOLSTAT stands for a complete range of Constant Voltage Transformers produced by 'Advance'—the leading authority on voltage stabilization. Full details in Folder D63 available on request.



COMPONENTS LIMITED

MAINS STABILIZATION DIVISION
ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · HAINAULT 4444



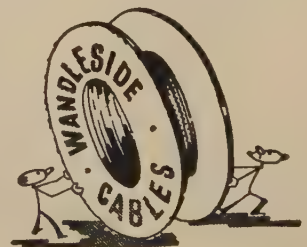
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To those engaged in work of National importance, there is no room for mistakes in the selection of equipment for vital engineering and scientific projects only the best will do.

This is why Wandleside Cables are so often specified in work of this nature. Every type of cable produced in their three factories is subjected to the most exacting tests to comply with British Standards, Government or other relevant specifications.

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With the combined resources of our Cable Group, we are able to offer the Electrical Industry a complete range of Rubber and Plastic Insulated cables for operating temperatures up to 1000°F.

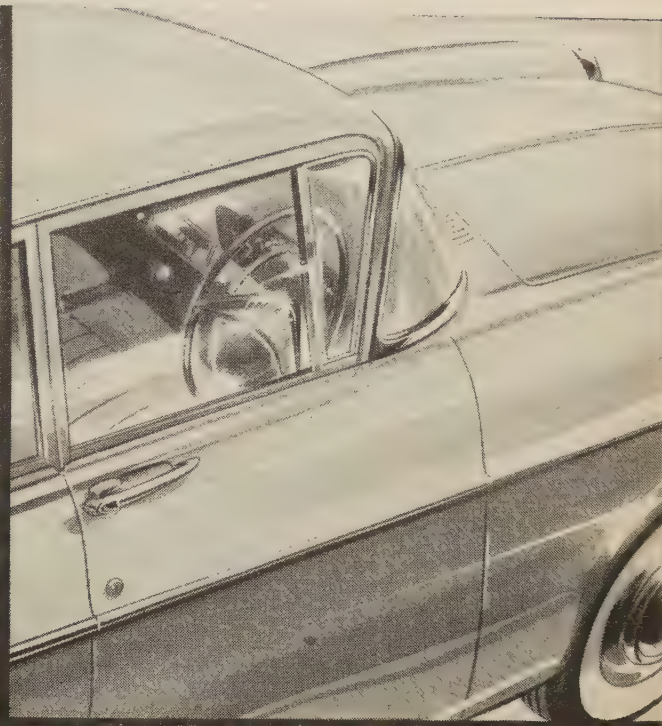
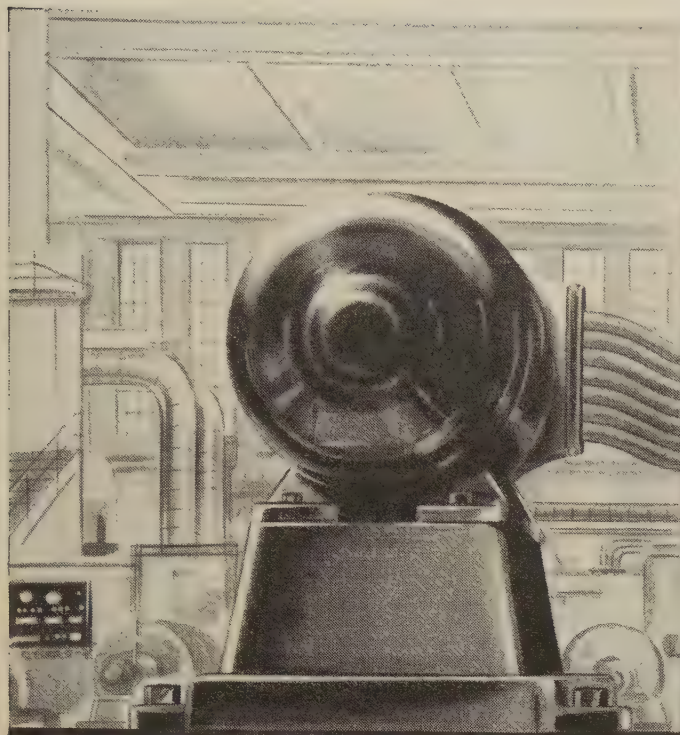


WANDLESIDE CABLES

In Association with: IRISH CABLES LTD.
WANDLESIDE WARREN WIRE CO. LTD. &
WANDLESIDE NATIONAL CONDUCTORS LTD.

WANDLESIDE CABLE WORKS LTD., 106 GARRATT LANE, WANDSWORTH, LONDON, S.W.18
Tel: VANDyke 7544 (7 lines) (in FALKS Group) Teleg: Wandleside London S.W.18

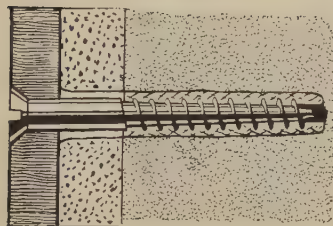
FASTENING HEAVY EQUIPMENT FIXING LIGHT COMPONENTS



RAWLBOLTS

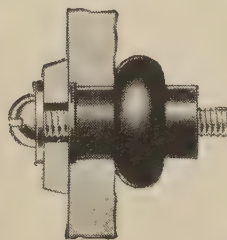
Where a bolt fixing is necessary or where extra heavy loads are involved Rawlbolts are the perfect fixing. They require no grouting, are instantly locked in the hole and enable machinery to be put into operation immediately. There are two types—loose bolt and bolt projecting to suit the nature of the job. Sizes are from $\frac{1}{8}$ " to 1" in various lengths.

RAWLPLUGS

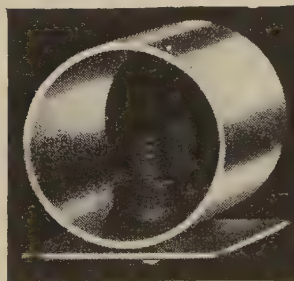


For screw fixings in solid materials Rawlplugs will take loads up to a million times their own weight. The tiny No. 3 ($\frac{1}{8}$ ") is used for fixing cable clips, the largest No. 30 (1") for fixing electrical and other gear to walls or floors will take direct loads up to four tons.

RAWLNUTS



In the range of Rawlplug Cavity Fixings the RAWLNUT has almost every advantage. It will make blind fixings in the thinnest of 'shell' materials, or in the larger sizes is suitable for hollow pot, or friable composition materials which will not hold conventional fixings. In situ it is vibration proof, waterproof, airtight, and insulative. It is extensively used in aircraft and car assemblies. There are sizes from $\frac{1}{8}$ " BSW to $\frac{1}{2}$ " BSW and alternative threads.



The illustration here shows how it is possible to fix a metal plate to a tube. It is also possible to stop a leak in a tank.

THERE ARE **24** DIFFERENT TYPES OF

FIXING DEVICES FOR SPEED AND ENDURANCE

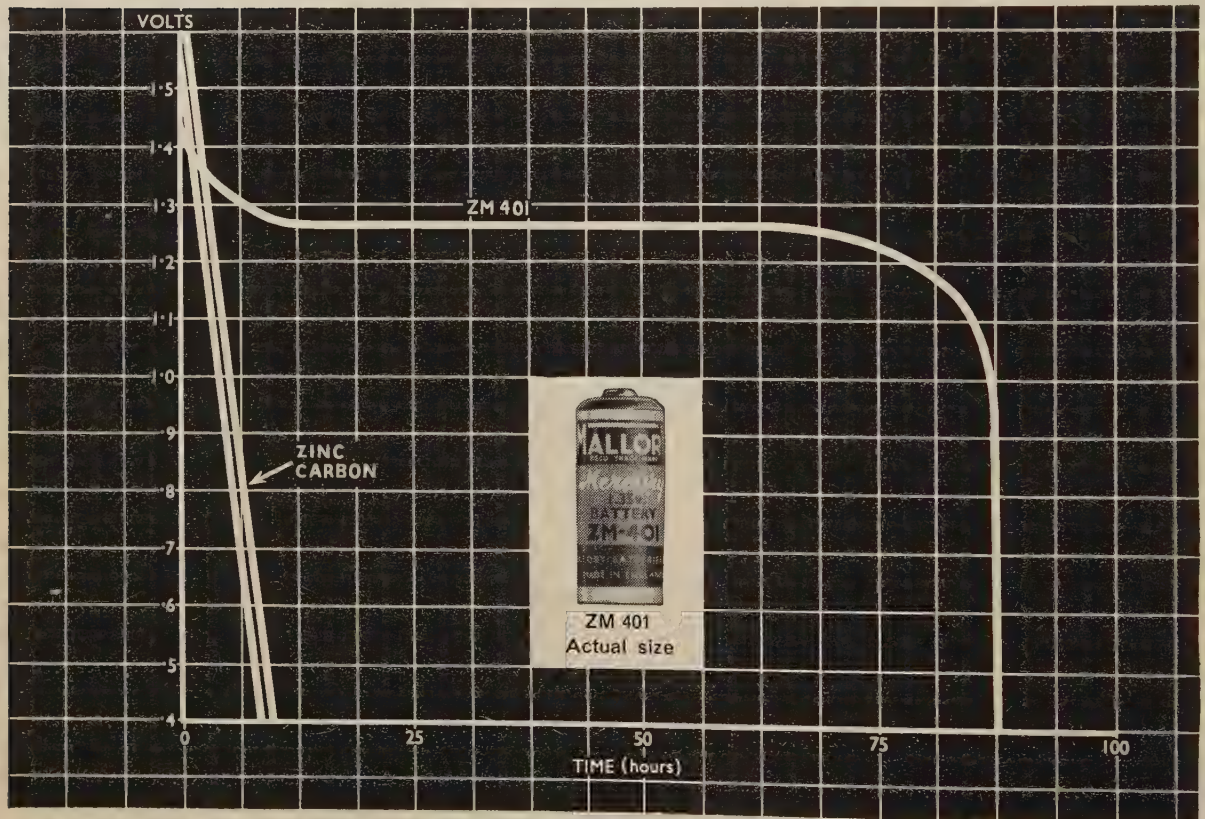


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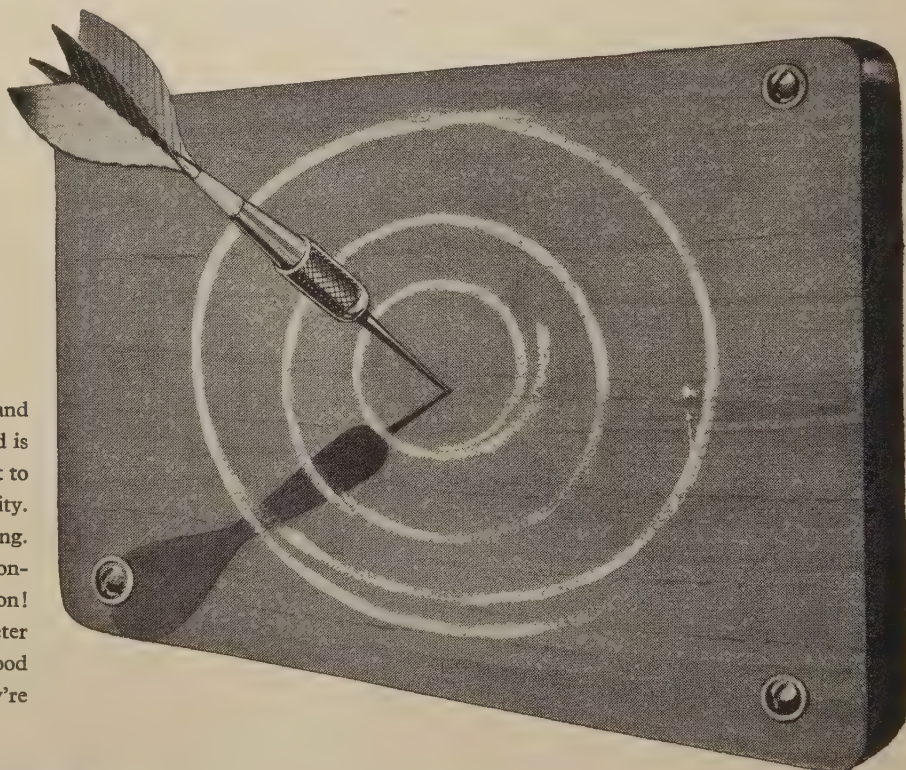


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Wootton meter boards score every time!

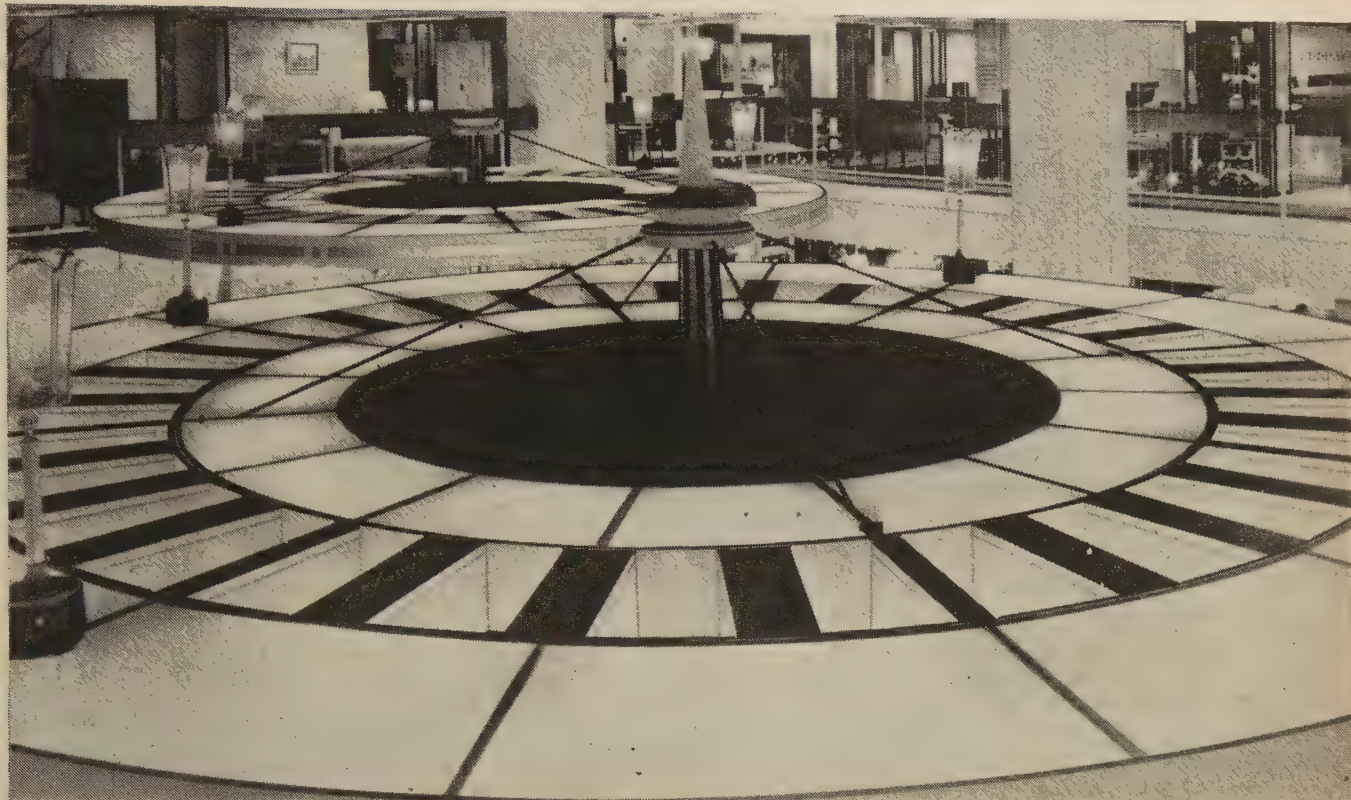
Bound to... if they're Wootton-made... and Wootton-tested! Only the stoutest plywood is good enough for Wootton. Every piece is put to the test. For reliability, toughness, durability. Wootton meter boards stand up to anything. Even in the most extreme climates. No contraction or expansion or warping with Wootton! Oh, and there's more to Wootton than just meter boards. They're right on the target with wood blocks too, and instrument cases, and they're brilliant at sunk switch boxes.



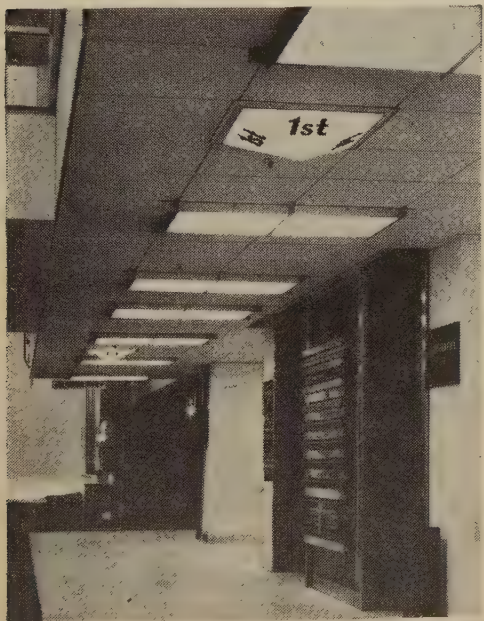
WOOTTON-the meter board people

WOOTTON & CO. LTD
ALMA WORKS · PONDERS END · MIDDX
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Three thousand panels of 'Perspex' in Harrison Gibsons new store



Lighting fittings made from Opal 040 'Perspex' acrylic sheet in use at Harrison Gibsons Furnishing Store, High Road, Ilford. The fittings were made and installed by F. W. Clifford, 29 Vauxhall Bridge Road, London S.W.1.



Luminous ceiling panels made from Opal 030 'Perspex' used in Harrison Gibsons. These fittings were made and installed by Courtney, Pope (Electrical) Ltd., Amhurst Park Works, London N.15

Among the most eye-catching features of Harrison Gibsons new Ilford store are these giant lighting fittings. The lightness of 'Perspex' acrylic sheet makes it ideal for such large fittings, but its many other outstanding characteristics make it the automatic first choice for many fittings of all sizes.

'Perspex' will stand up to rough handling and cleaning and is free from danger of yellowing. Its excellent optical properties include high transmission in opal grades. 'Perspex' sheet is available in a wide range of light transmissions and colours, in clear or opal grades. For more information, please enquire from your local I.C.I. Sales Office.

'PERSPEX'

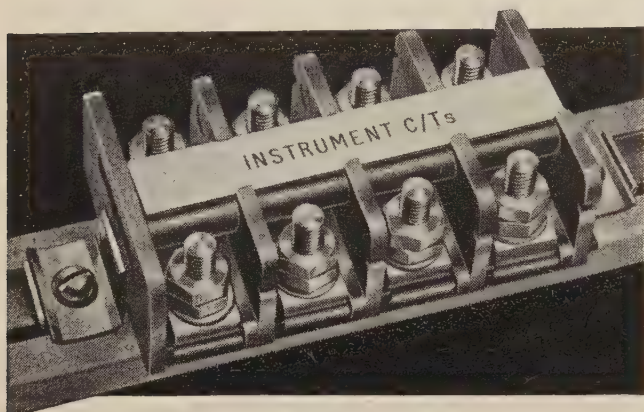
'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

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FP78



BETA TERMINAL BLOCKS IN MOULDED NYLON



- Designed for simple and economical grouping of any number of ways.
- Extra ways can be added without dismantling or further drilling.
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- Tested to 4000 V. between terminals and to earth.
- Available with 0 B.A. and 2 B.A. studs.
- Moulded in NYLON, highly resistant to tracking and virtually unbreakable.
- Approved by C.E.G.B.

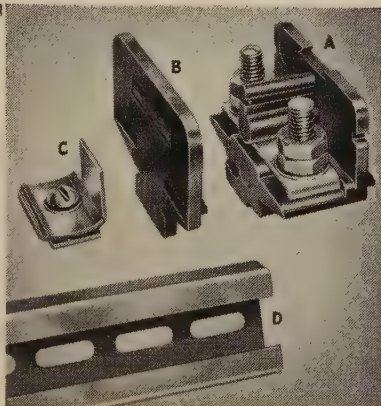
BASIC UNITS

A Body in moulded Nylon with brass connecting link with either 2 B.A. or 0 B.A. studs.

B Moulded Nylon barrier. Required only at one end of group.

C Cadmium plated steel end clamp, one required at each end of group.

D Cadmium plated slotted steel channel.



REF: 1106

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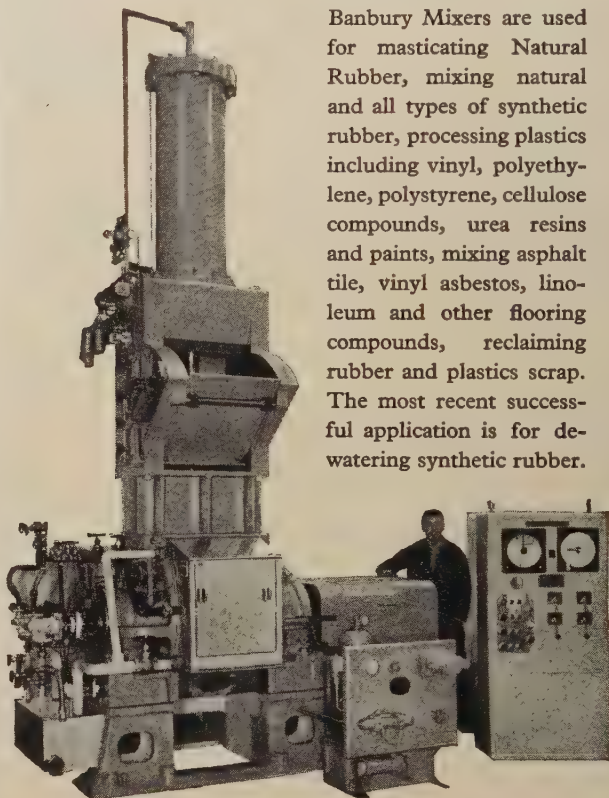
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Material produced in a Banbury Mixer is of consistent High quality.

Banbury Mixers are used for masticating Natural Rubber, mixing natural and all types of synthetic rubber, processing plastics including vinyl, polyethylene, polystyrene, cellulose compounds, urea resins and paints, mixing asphalt tile, vinyl asbestos, linoleum and other flooring compounds, reclaiming rubber and plastics scrap. The most recent successful application is for de-watering synthetic rubber.



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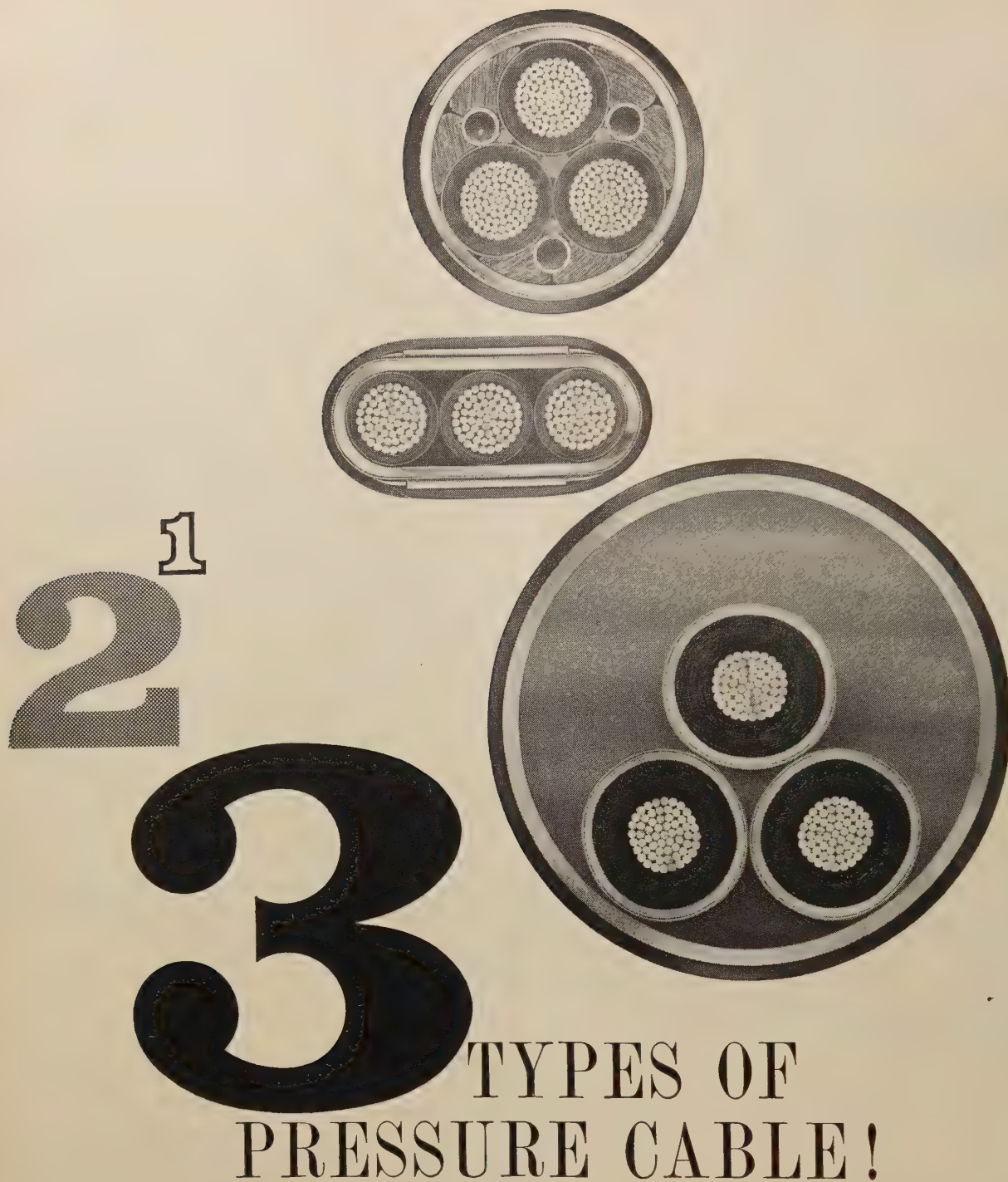
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- * Economy—NO BIG OUTLAY OR INSTALLATION PROBLEMS.

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80 Watt - 400 Watt MBF/U Mercury Discharge Lamps.

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May we send you details?

REAL
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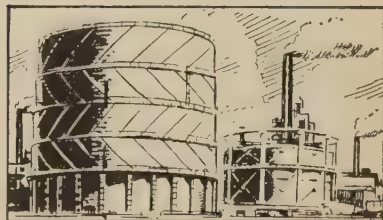
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ROWLANDS ELECTRICAL ACCESSORIES LTD., R.E.A.L. WORKS, BIRMINGHAM 18



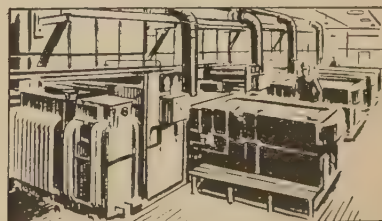
LOCOMOTIVE SHEDS "installed over a railway turntable . . . not been attacked in any way by the corrosive fumes . . . interior of the reflectors perfectly clean."



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ELECTRO PLATINGWORKS. "We would say that, in our opinion, it is a fitting ideally suitable for the corrosive atmosphere of a Plating Shop."

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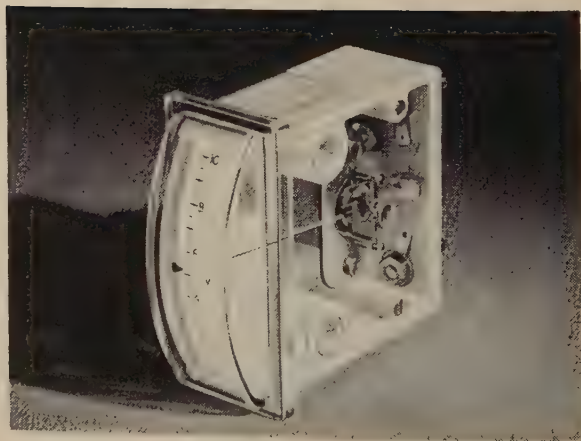
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The Series 22 (edgewise 2.25" scale)—with internal magnet moving coil D.C., rectifier internal magnet moving coil A.C., and moving iron A.C. and D.C. Choice of horizontal or vertical, front or rear mounted.

See for yourself, write for details of the Clear View range.

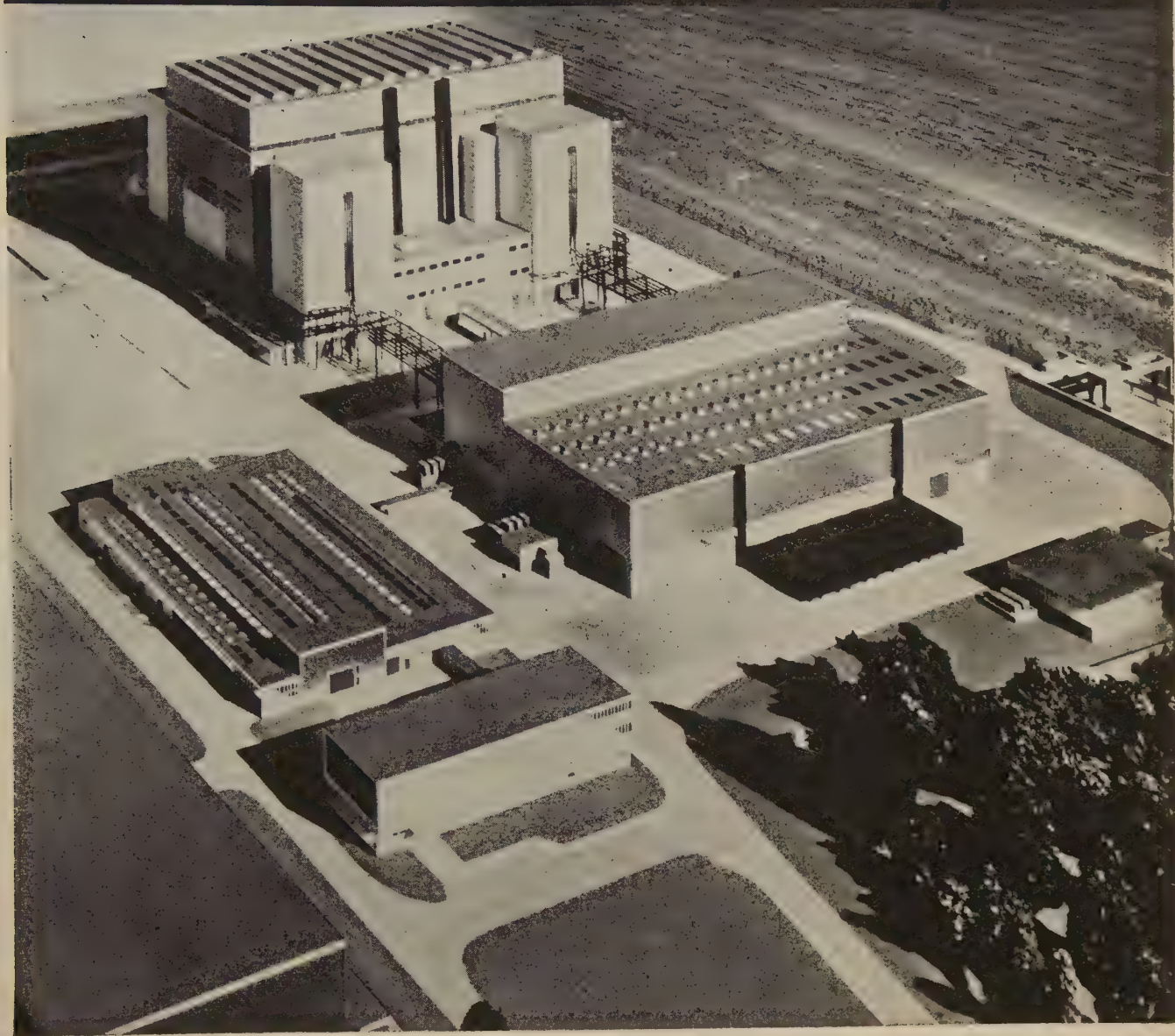
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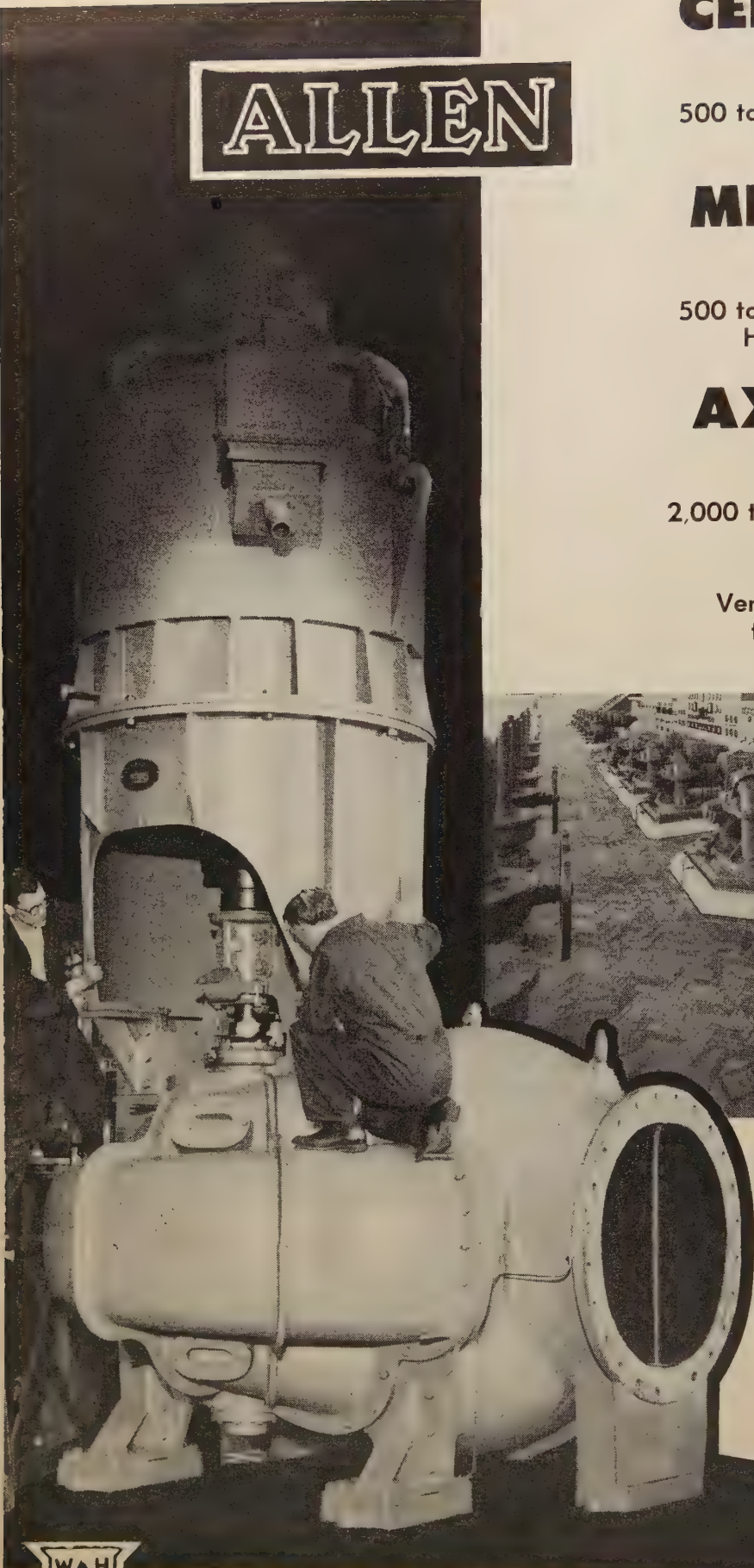
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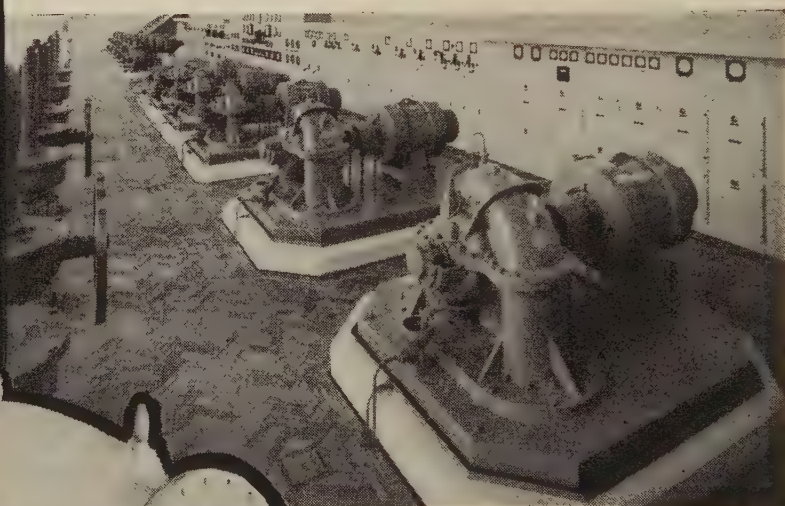
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to suit all requirements



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Left: A 31,000 gallons per minute 40 in./38 in. ALLEN vertical double-suction pump for power station circulating water.

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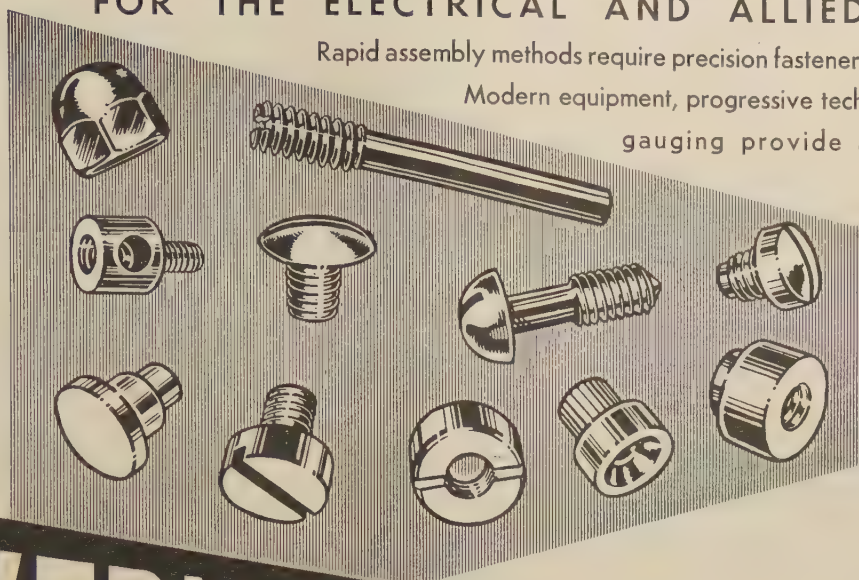
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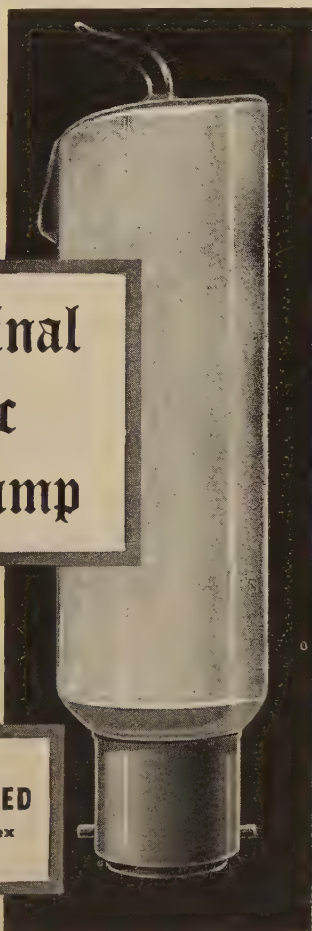
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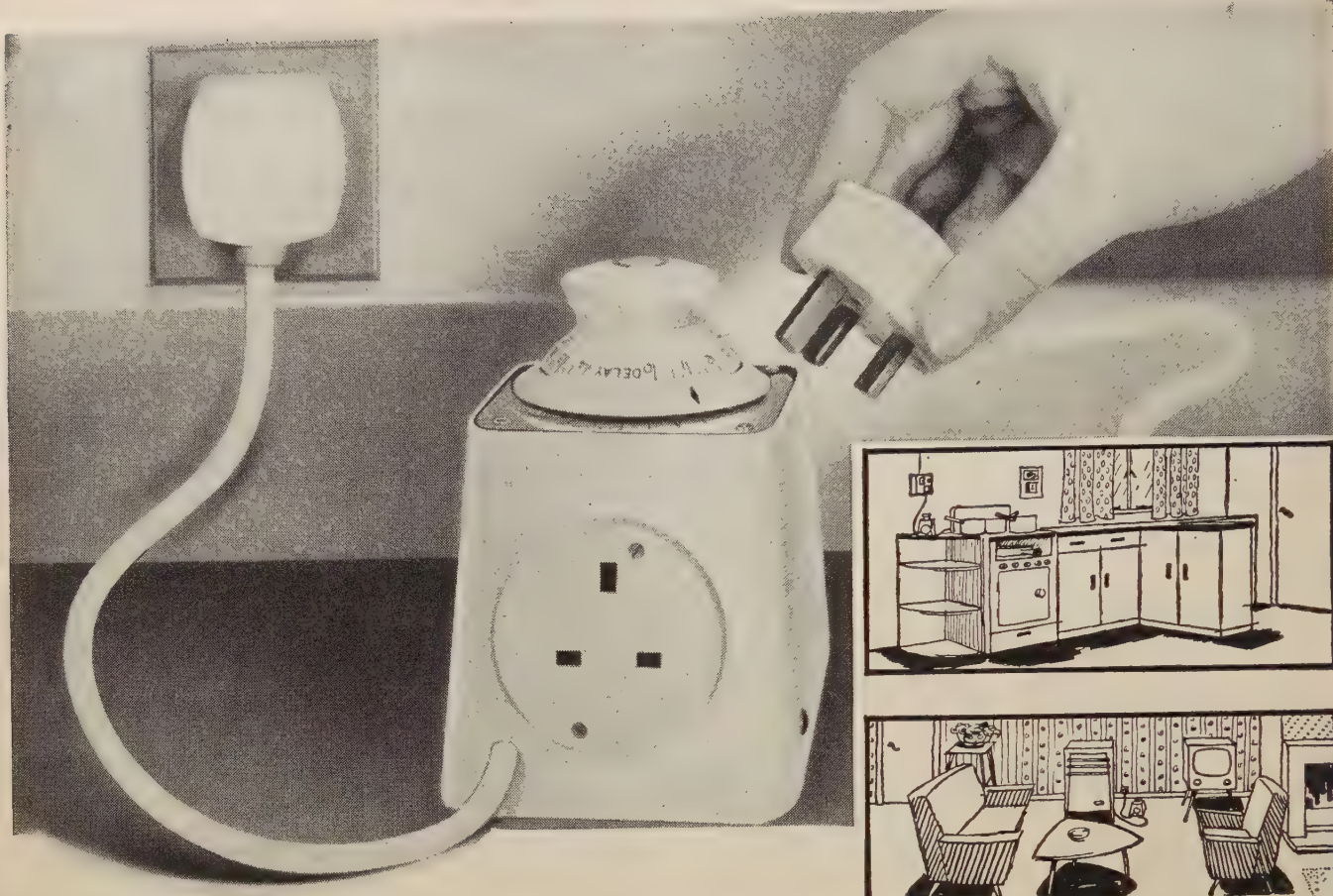
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Modelling a harbour installation
at the Wave Basin to study
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S.W.S. Type UEI.

The ***ONLY***

33kV

PACKAGE SWITCHGEAR
fully proven in service
all over the world

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Over the past years S.W.S. type UEI metal-enclosed switchgear has earned a world wide reputation for reliability in service. Since its introduction this 33kV vertically isolated, single and duplicate busbar package unit has proved all claims made for it.

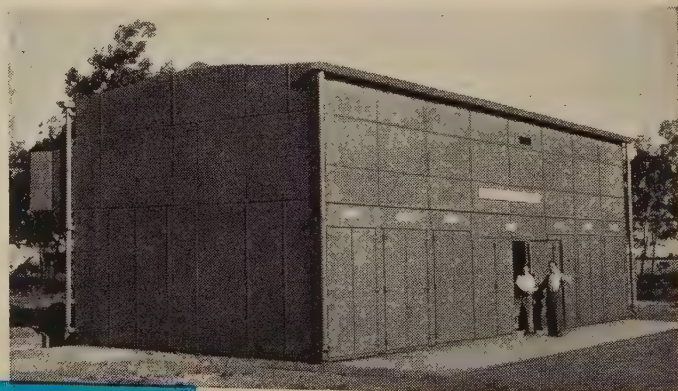
Simplification of preparatory site work and complete assembly at the works make for easy and fast erection; the package unit illustrated bottom right was erected in 21 days.

Safety in service in any climatic conditions is ensured by the porcelain insulation and the design allows 'in situ' inspection in all weathers.

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33kV Package Switchgear Unit in South America.



33kV Package Switchgear Unit in South Africa.



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Preformed

**HOLDS
THE
LINE....**



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... because the unique Helical gripping of PREFORMED Dead Ends* gives low localised stress. It holds the extra high tensile steel core of this revolutionary type cable through five slip surfaces without damaging the polythene sheath. This is an outstanding example of the extreme holding power of PREFORMED Dead Ends. Easily and quickly applied—PREFORMED Dead Ends are the discerning engineers choice.

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*Patent Application Number 817535

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Other products mentioned are covered by patent and patent application Nos. 817055, 817534, 805333, 817643, 817644, 788908, 817535

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**+ REVERSED
POLARITY—**

Reversed polarity versions of Mullard 20 amp Silicon Power Rectifiers bring new economies

To give designers a choice of either cathode or anode mounting, Mullard have added two new, reverse polarity, Silicon Power Rectifiers to their range. These new rectifiers, the BYZ15 and the BYY16 complement the BYZ14 and BYY15—the well known, rugged, 20A, 200 and 400V industrial silicon rectifiers.

The addition of these two new types to the Mullard range of rectifiers not only offers designers more freedom in mechanical design, but also the advantage of reducing the number of heat-sinks required consequently reducing costs and saving space.

ABRIDGED DATA

	BYZ14	BYZ15	BYY15	BYY16
Max. recurrent P.I.V. voltage (V)	200	200	400	400
Max. transient peak voltage (V)	400	400	800	800
Max. average current (A)	20	20	20	20
Max. recurrent peak current (A)	100	100	100	100
Max. junction temperature °C	150	150	150	150
Mounting base	Cathode	Anode	Cathode	Anode



Except for mounting polarity, information on the BYZ15 and the BYY16 reverse polarity rectifiers is exactly the same as that shown on the BYZ14 and BYY15 data sheets. For these or other information, please write quoting reference V4011 to:

MULLARD LIMITED Semiconductor Division Mullard House
Torrington Place London WC1 Tel: LAngham 6633

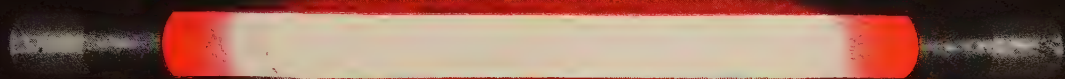


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Sizes ranging from 2" — 72" heating sections



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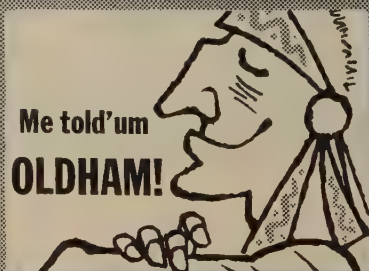
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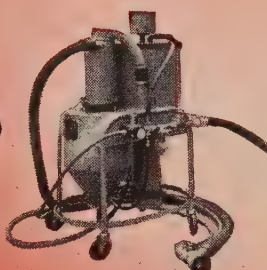
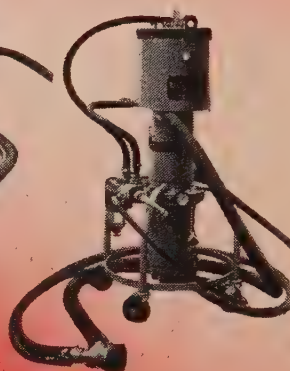


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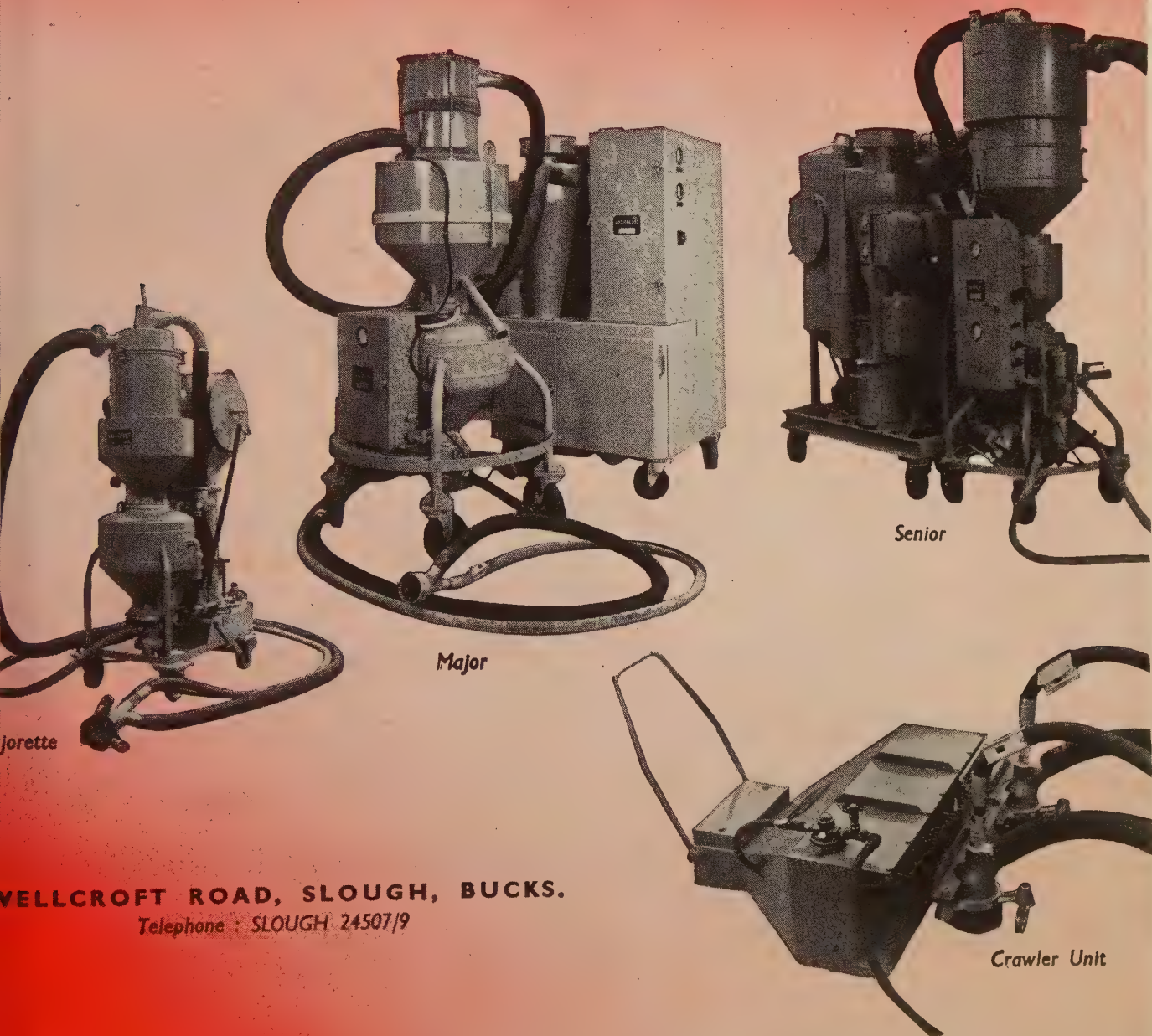
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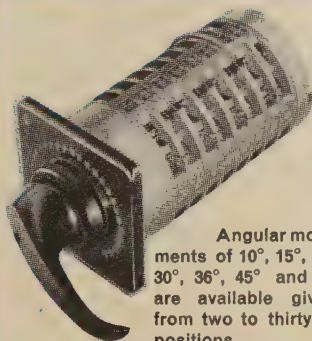


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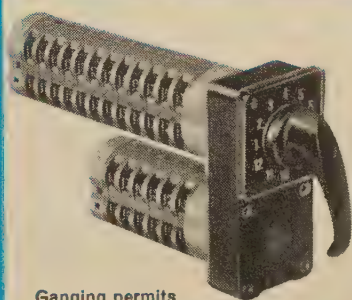
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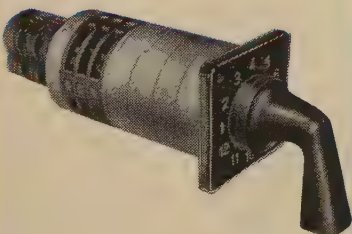
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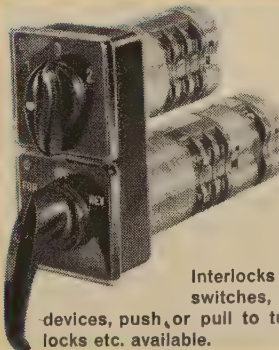
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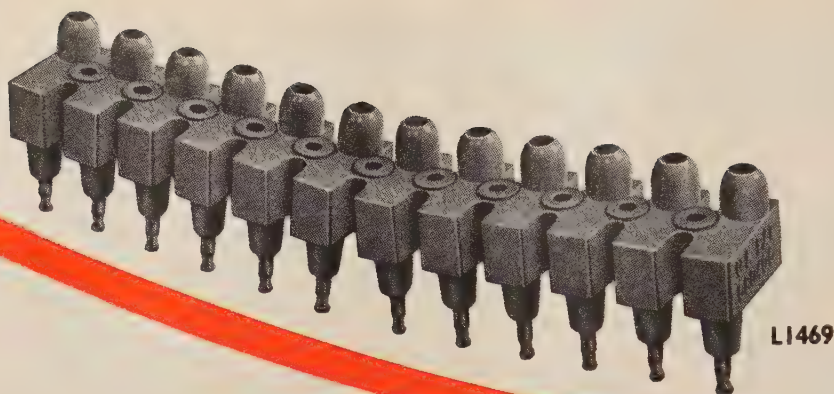
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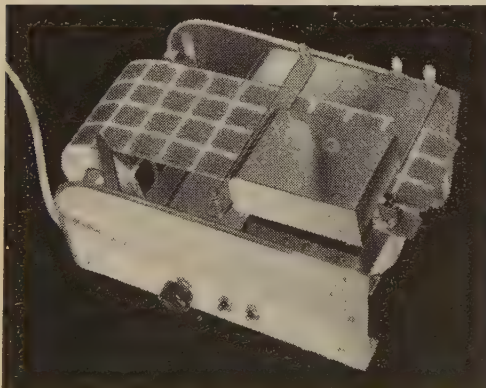
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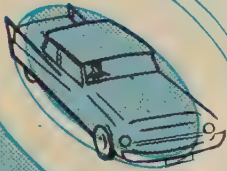
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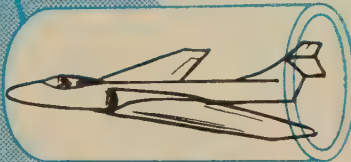
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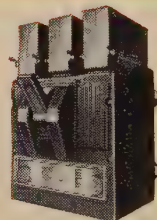
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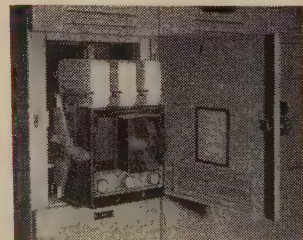
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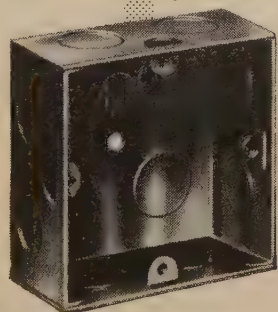


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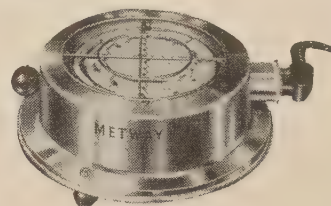
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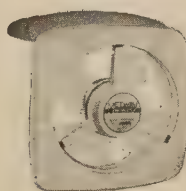
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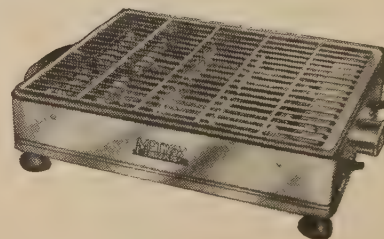
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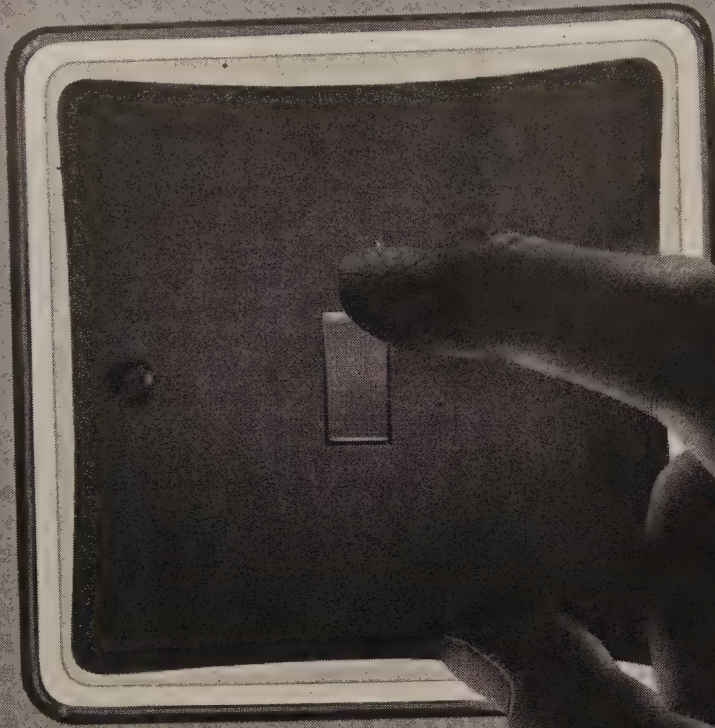


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ELECTRICAL REVIEW

Friday 17 November 1961 Volume 169 No 20

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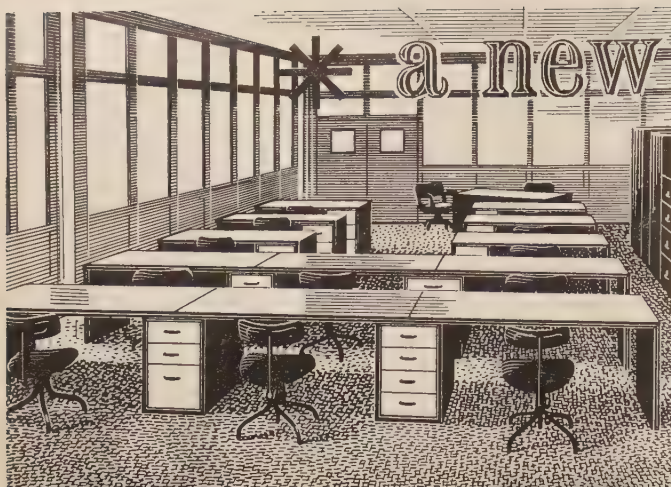
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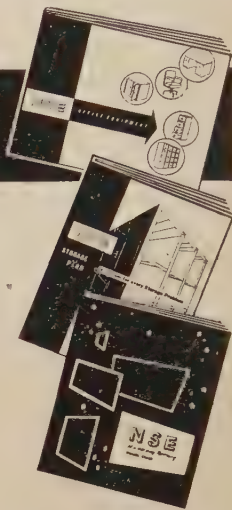
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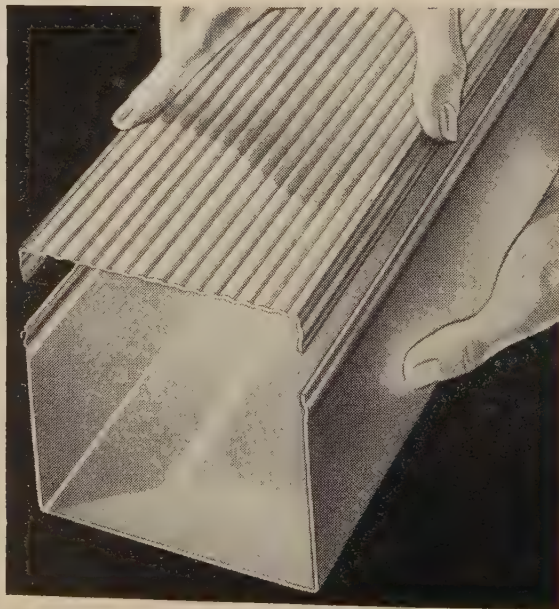
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17 November 1961 Vol. 169 No. 20 Established 1872

Nuclear Economics

WHEN, in the indeterminate future, this country's coal seams are exhausted, with the drain on the world's oil reserves proceeding at an ever-increasing rate, we shall be forced to rely on alternative sources of power. It seems certain that the principal source must be atomic energy and so we are now building a series of nuclear power stations, the first two of which will begin to operate early next year.

Unfortunately, electricity produced by these stations will cost much more than that from modern coal-fired plant, and this may have an adverse effect upon industry which comes to rely more and more on electricity for power and heat. But the future situation may not be so bad as would appear at present. Since no large civil nuclear power station is yet operating, estimates of the cost of nuclear power have been based, with necessary adjustments, upon the operation of Calder Hall. These calculations have been based on a 75 per cent load factor and a reactor life of 20 years. The same load factor is also assumed for conventional stations when assessing the relative costs of coal-fired and nuclear plants. We feel that this is a very doubtful sort of comparison. Calculations and comparisons should have regard to the overall economics of an integrated system.

If the combined cost of electricity generated by separate base and peak load stations is less than the cost from a single base and peak load type of station, then there is an obvious economic advantage in operating the two different types of station in parallel. In an article in the *Electrical Review* of 25th December, 1959, Dr. Charles Jaeger showed how to calculate this cost ratio. In general, it is that a system consisting of high capital cost, low running cost base load stations combined with low capital cost, higher running cost peak load stations, can be operated economically.

The present type of civil nuclear power station has high capital costs and relatively low running costs and is consequently suited to base load operation. If a load factor of 90 per cent and a reactor life of 25 years were used in the calculations instead of 75 per cent and 20 years, then the cost of electricity from the present series of nuclear power stations would be reduced by from 0.08 to 0.10d/kWh. Fortunately, the Calder Hall type reactors are technically as well as economically suited to base-load operation. After five years' operating experience at Calder Hall itself there seems to be no reason to doubt an availability of over 90 per cent and a life of more than 20 years (see

our leading article of 20th October). On the other hand, a coal-fired station has lower capital costs and higher fuel costs than a nuclear power station and is, therefore, more suited to lower load factor operation—lower probably than the 75 per cent normally assumed by economists.

All this would suggest that, even at the present stage of development, nuclear power is more attractive than is generally conceded. This does not mean that the development programme should be slowed down. Whatever the basis of the estimates, reductions in power costs are dependent on the degree of progress made by developments in nuclear engineering, which have yet a long way to go.

CAPITAL COSTS

The main component in the cost of electricity from nuclear power stations is the capital investment per kW of electrical output capacity. The capacity of any type of plant can be raised by increasing its efficiency while the capital cost per kW can be reduced by increasing the heat rating of the fuel, thereby obtaining more heat from the same size of plant.

The cooling gas outlet temperature in the civil nuclear reactors now under construction is about 750°F and, therefore, their thermal efficiencies will be very low when compared with modern coal-fired stations. The efficiency of a nuclear plant can be improved by increasing the fuel temperature and the output can be further raised by increasing the rate of heat removal from the surface of the fuel elements. An increase in gas pressure will increase fuel rating slightly, but major improvement results from increasing the surface area of the fuel. Thus, a significant improvement in costs can be obtained only by adopting a shape of fuel element different from that employed in the magnox reactors and these elements must be capable of withstanding higher temperatures. This is a radical change and is the basic reason for the development of the advanced gas-cooled reactor at Windscale.

ENRICHMENT

The new type of fuel element which will be used in the A.G.R. is composed of enriched uranium, which means that the fuel cost will be about double that for magnox stations. But this can be counterbalanced by doubling the burn-up which in magnox reactors is expected to be 3,000 MWd/te and at least 6,000 MWd/te in the A.G.R. If, in fact, the figure is increased to 12,000 MWd/te, as suggested in the article by Sir William Cook in this issue, costs will be further reduced. Sir William believes that there would be a 15 to 20 per cent capital cost reduction for a developed A.G.R. when compared with a magnox station, giving a 10 per cent overall reduction in electricity costs, assuming a 6,000 MWd/te burn-up. (Fuel costs remain constant while capital costs decrease.) However, burn-ups of over 6,000 MWd/te are con-

fidently expected so that the economics of an integrated system, mentioned above, would probably not be affected.

The capital cost of the first civil A.G.R. station may be slightly more than that of the immediately preceding magnox station because, as Mr. C. W. A. Priest states in this issue, the magnox system can be still further developed. However, the magnox cost curves are now flattening out and, Mr. Priest points out, the first phase of civil nuclear power stations is inevitably reaching its end. Only by a change to an advanced reactor system can large cost reductions be secured. A figure of 0.45d/kWh for a developed A.G.R. is forecast in Mr. R. V. Moore's article.

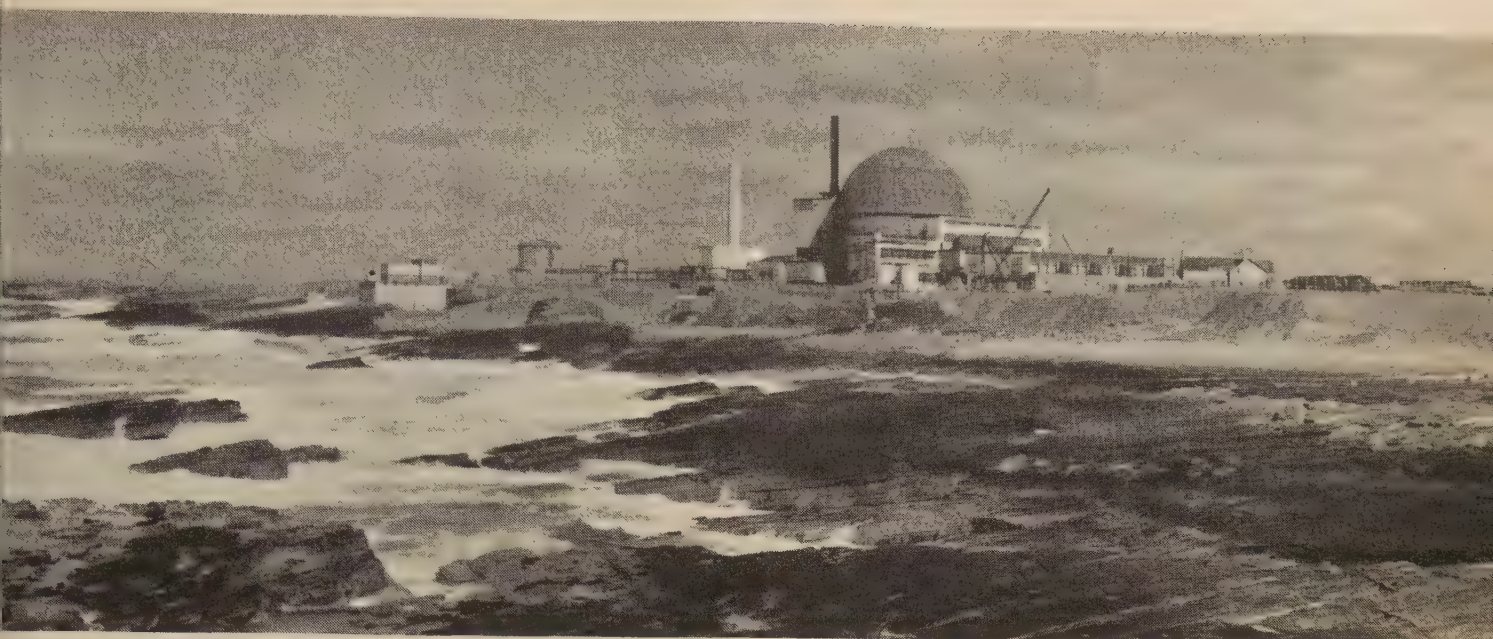
When should there be a change from magnox to A.G.R. stations? There is perhaps an understandable reluctance on the part of the manufacturers' consortia to change to a different type of reactor until the expensive prototype stage has been completed. It is to be hoped that this will not unduly delay the commencement of the first civil A.G.R. Both Sir William Cook and Mr. Priest refer to other possible second stage reactor systems but neither the high temperature gas-cooled reactor at Winfrith nor a proposed water reactor system is sufficiently developed for immediate purposes. It is, in fact, doubtful whether there would be any significant economic advantage in a water system as compared with the A.G.R. In this issue, we therefore include a detailed description of the Windscale A.G.R. since this system seems at present to be the most likely one to meet the requirements of the British nuclear power programme.

POSSIBLE FUTURE SYSTEMS

Development of fast fission breeder reactors is centred on the Dounreay experiment, but as Sir William Cook points out, the Dounreay reactor stands in relation to a commercial version almost in the position of BEPO to Berkeley. However, it is hoped that the commercial stage will be reached by the 1970's.

Looking much further into the future, it may be found that nuclear fusion or thermonuclear energy can be harnessed for electrical power production. The best chance of success appears to be the use of a plasma. This poses containment problems which are pre-occupying all the laboratories engaged in this type of work at the present time. Current lines of development are discussed in the article by Dr. P. A. Davenport. It must, however, be stressed that research programmes are still at the stage of exploring the feasibility of controlled fusion power.

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The fast breeder reactor at Dounreay

Reactor Development in the United Kingdom

By SIR WILLIAM COOK, C.B.*

The Present and Future Pattern

BRTAIN'S present nuclear power programme is, of course, based on Calder Hall, but it is worth recalling that at the time the decision was made it was an act of faith which has been well justified by the experience of five years' operation.

The Calder type (which has come to be known as the uranium-magnox reactor from the fuel and canning material used) has shown itself capable of considerable development in size and consequent output. The first designs produced by the consortia gave a fourfold increase in net output per reactor at Berkeley and Bradwell, now almost at the point of feeding their first output to the grid. Since then, successive advances have added another factor of nearly two, so that each reactor at Sizewell will provide more electricity than was expected from all eight reactors at Calder and Chapelcross combined. Moreover, operating experience at Calder has led to modifications which will increase the net output by 25 per cent,† an encouraging augury for the civil stations.

These large and rapid increases, with resulting reductions in generating costs, have been achieved, with the civil stations, by increasing the reactor size, raising the pressure of the coolant gas and increasing the MW/tonne fuel rating. The increases in size and pressure have been made possible by the use of thicker pressure vessels which, in turn, has been largely dependent on the development of

improved methods of plate and weld fabrication and examination.

As a result of these and other developments, the economic performance of the stations has been considerably improved; for example, the capital cost of Trawsfynydd is expected to be over 20 per cent less than that of Bradwell or Berkeley in terms of £/kW installed, and a substantial improvement in unit generating cost is expected. Further reductions in capital cost and generating cost should be evident in later stations such as Sizewell and in subsequent stations such as Oldbury.

Advanced Gas-Cooled Reactor

The one parameter in which scarcely any improvement has been shown is the temperature at which the coolant leaves the reactor. The limit here is set by the fact that the fuel element makes use of natural uranium metal canned in magnox. By substituting enriched uranium oxide for metallic oxide and canning in stainless steel or beryllium it is possible to obtain bulk outlet temperatures of about 520°C—an increase of 120°C over the magnox stations. The change in fuel element and the more compact design of the heat exchangers in relation to the reactor should mean, in a developed commercial version of the Windscale Advanced Gas-Cooled Reactor (A.G.R.), a reduction of 15 to 20 per cent in capital costs as compared with magnox stations.

The use of enriched uranium and the more elaborate

* Member for Reactors, United Kingdom Atomic Energy Authority.

† See leading article, *Electrical Review*, 20th October, 1961.

form of the fuel elements both lead to higher costs per ton of fuel, but this will be offset by the higher irradiation levels anticipated. Compared with the expected burn-up of 3,000 MWd/tonne in the magnox reactors, the A.G.R. figure is expected to be at least 12,000 MWd/tonne with the prospect of further increases with continuing development.

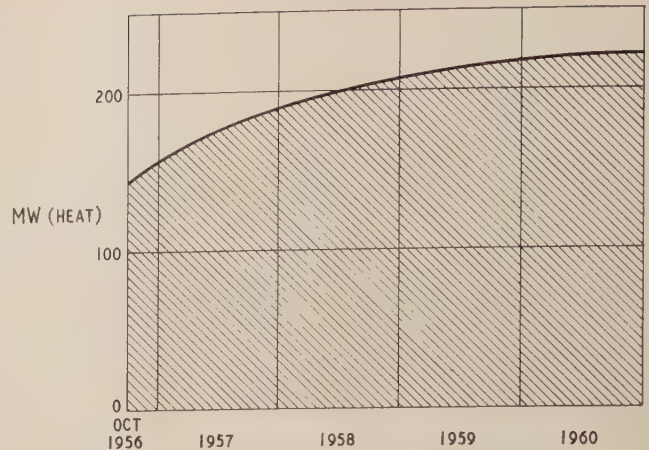
Taking into account both capital costs and fuel costs, we would expect the generating costs in a developed A.G.R. to be about 10 per cent below those of the magnox stations.

Both the magnox reactors and the A.G.R.'s will produce plutonium as a by-product. The economics of both magnox and A.G.R. systems will, of course, benefit from whatever price is payable for the plutonium produced and this, in its turn, depends on finding the most economical method of using plutonium fuel.

Fast Reactors

The main work in this field is centred on the fast fission breeder reactor, and the reactor experiment at Dounreay, which began operation in November, 1959. This entirely new concept raised a number of design problems, while the start of operations produced a further crop, and there is no doubt that others will develop as the power level of the reactor is raised and the burn-up of the fuel is increased. Solutions have been found, but there is still much to be achieved, and more experience will be needed before the design of a prototype on a larger scale can be settled with confidence.

Nevertheless, operation of the reactor to date has yielded useful information in respect of both design and operational problems and this information makes it clear that the larger-scale prototype will be materially different from a scaled-up version of the Dounreay fast reactor, which stands in relation to a commercial reactor almost in the position of BEPO relative to Berkeley. Apart from the engineering and metallurgical problems, the selection of a satisfactory plutonium fuel is a major development project. Possible variants are plutonium/uranium oxides,



Graph showing increase in average reactor power (heat) at Calder Hall since the start of operation

plutonium/uranium carbides or dispersions of these materials in a stainless steel matrix to form a cermet. The accumulation of information on these various fuels requires considerable experimental work in the fields of fabrication, out-of-pile proving and irradiation testing. It is hoped that this reactor concept can be developed to a commercial stage by the 1970's, but a considerable development effort will be required over the next decade.

Dragon Project

Already the Authority are considering the possibilities of higher outlet temperatures and greater efficiencies beyond those envisaged in the A.G.R. and for this reason we are putting a good deal of work into the programme on the High-Temperature Gas-Cooled Reactor which is being developed as the O.E.E.C. Dragon Project at Winfrith. This carries the gas-cooled graphite-moderated type of reactor another stage forward and uses a dispersion of the fissile material in graphite together with a graphite fuel container, thereby incorporating a portion of the moderator into the fuel element. The coolant will

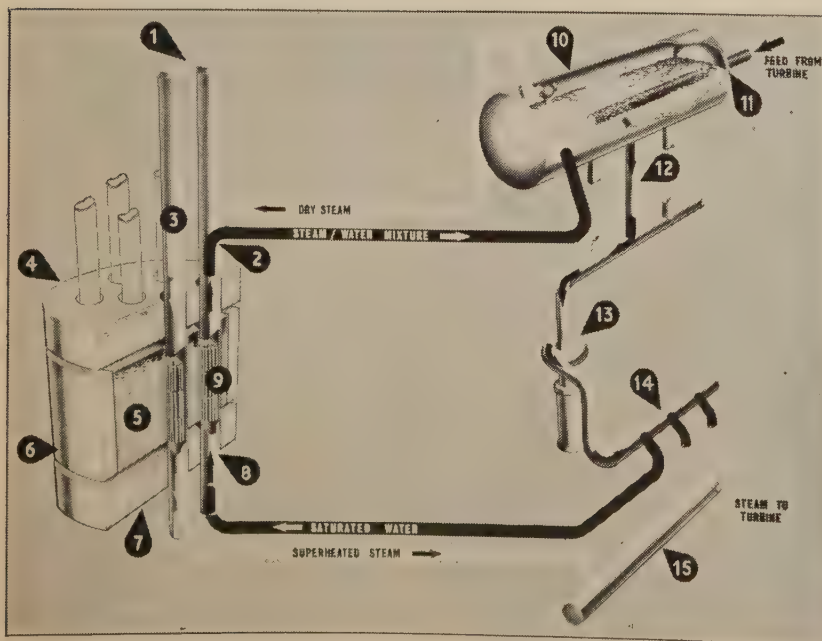


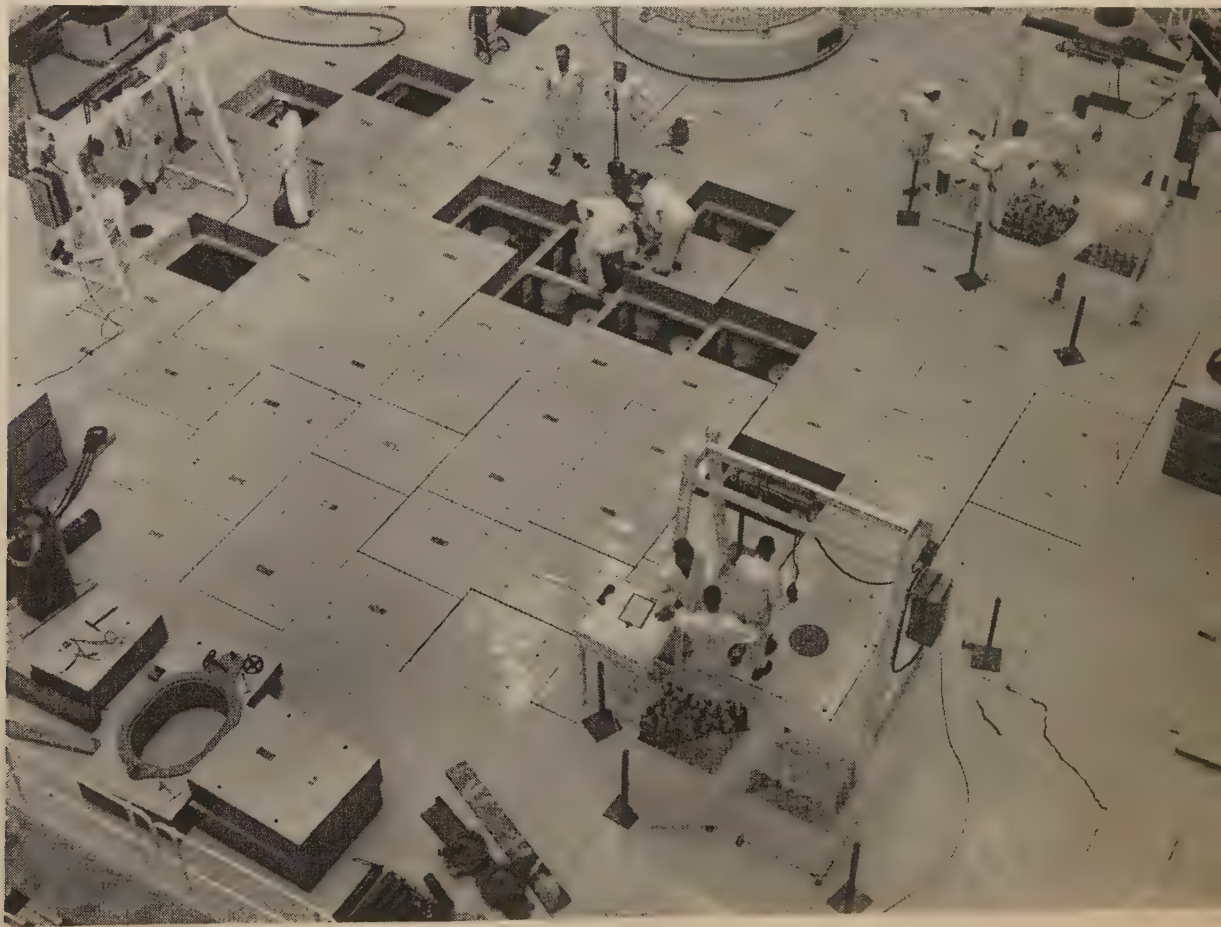
Diagram of the Steam Generating Heavy Water Reactor

- (1) Refuelling standpipes. (2) Boiling channel. (3) Superheat channel. (4) Top thermal shield. (5) Moderator. (6) Side thermal shield. (7) Bottom thermal shield. (8) Evaporating channel. (9) Fuel. (10) Steam drum. (11) Water level. (12) Downcomer. (13) Circulating pump. (14) Water header. (15) Steam header.



Model of the Dragon reactor at Winfrith

Hand loading of uranium fuel into No. 1 reactor at Bradwell. The boxes of fuel elements and loading gantries can be seen at the three loading stations. The amount of fuel loaded is logged at the desks at each loading point. Criticality of this reactor was achieved on 19th August, 1961



Design Concept of the A.G.R.

By R. V. MOORE, G.C., B.Sc., M.I.Mech.E., M.I.E.E.*

The development potentialities of the gas-cooled graphite-moderated reactor have led to the construction of the Advanced Gas-Cooled Reactor at Windscale, Cumberland. The basis of its design philosophy is described and the experimental programme, designed to solve the remaining uncertainties, is discussed. It is expected that civil A.G.R. stations will reduce generation costs to 0.45d/kWh

FOR a number of years, it has been appreciated that the carbon-dioxide-cooled, graphite-moderated reactor had potentialities for development. In particular, it was realised that:—(a) Calder Hall type reactors, as currently being built in the U.K., could be developed considerably; (b) a promising line of development was towards higher temperature operation, leading to higher efficiencies, coupled with higher fuel ratings and longer burn-up; and (c) this required the development of new fuel materials and the use of low enrichment.

To further the development of this type of reactor it was decided to build an experimental Advanced Gas-Cooled Reactor (A.G.R.) at Windscale which would be fuelled with uranium, in oxide instead of metallic form, clad in a material having a rather higher melting point and strength than the magnesium alloy used hitherto. Construction on the site started in October, 1958, and the plant is now nearing completion.

The main terms of reference for the Windscale A.G.R.

were:—(i) To provide statistical information on the behaviour of uranium dioxide fuel elements clad in stainless steel and beryllium when operating under the conditions of temperature and irradiation appropriate to an A.G.R.; (ii) to provide an irradiation facility for the continued development of advanced fuels; (iii) to determine the behaviour of the graphite moderator under A.G.R. conditions; (iv) to provide information at high pressure and temperature on the compatibility of carbon-dioxide with reactor materials generally; and (v) to determine the safety and control problems of highly irradiated graphite-moderated, gas-cooled reactors.

The primary purpose of the experimental A.G.R. with its loop facilities is to provide statistical information on the performance of fuel elements over a range of temperatures and ratings spanning those forecast for commercial power-producing reactors of this type. The choice of size for

* Managing Director, Reactor Group, United Kingdom Atomic Energy Authority.

REACTOR DEVELOPMENT IN THE UNITED KINGDOM

(Continued from page 772)

be helium and it is planned to operate at temperatures approaching 1,000°C. However, the Dragon reactor is not yet built and it is a little too early to assign a precise place for this system in the future pattern of nuclear power production.

Starting with Calder Hall and proceeding through the more sophisticated concepts to which I have referred above, the Authority have concentrated mainly on the gas-cooled graphite-moderated reactor, to provide the large stations needed for the U.K. nuclear power programme.

Water Systems

One cannot and should not, however, overlook the fact that a number of other countries have devoted considerable effort to developing water systems, some of which show promise over a range of sizes. In small sizes, say below 150 MW, water systems are probably better than the magnox and A.G.R. systems.

Having taken major steps and achieved marked success in the gas-cooled graphite-moderated field, the Authority are now considering the deployment of further effort on

water systems. Almost every country with a major interest in nuclear power has included some of these systems in its research and development programme.

One form of heavy-water-moderated reactor which has received detailed study is that known as the Steam Generating Heavy Water Reactor. In this reactor, the fuel is cooled by ordinary water which is allowed to boil in one region of the core, the resulting steam being superheated in the second region. So far as these studies have gone, such a system looks promising over a large range of sizes.

It would, in my view, be unwise to look further into the crystal ball at this moment of time and attempt to prophesy the state of the art 15 or 20 years from now. We, and other countries, have made great advances in this new technology in the last 15 years and I have no reason to believe that the next two decades will be less eventful and exciting. If Britain keeps a mind open to new ideas and prosecutes its plans with the vigour and enterprise which it has shown hitherto, I am confident we shall maintain our leading position in the nuclear power field.

the experiment was therefore largely determined by the number of channels required to give statistical information over a range of fuel ratings and to accommodate experimental facilities. This led to a design based on an estimated heat output of 100 MW and sustained operation at this power readily justifies the incorporation of an electrical power plant having a net output of about 28 MW. The reactor is designed for a range of gas inlet temperatures from 250 to 325°C and of outlet temperatures from 500 to 575°C. A range of fuel ratings is readily obtained by not attempting to flatten the core and the peak in the Windscale A.G.R. is expected to be between 18 and 20 MW/tonne of uranium.

Fuel Elements

In an A.G.R., higher temperatures and fuel ratings are made possible by changing from magnesium to stainless steel for the cladding material and by using uranium dioxide instead of metallic uranium to permit the use of higher fuel temperatures by obviating the problem of swelling associated with the latter at temperatures above about 600°C. The low thermal conductivity of uranium dioxide demands that heat flow paths within the fuel must be kept short to avoid excessively high centre temperatures with associated fission product gas release into the can. A large surface area must, in consequence, be provided. The design comprises a cluster of pencil-like fuel elements, chosen because of symmetry and because of the ability of a cylindrical can to withstand internal or external pressure. Support grids carry the individual fuel elements, and graphite sleeves provide structural support in compression, a smooth exterior surface to assist refuelling and a flow and thermal barrier between coolant flow paths. A central tie-rod takes the tensile load occurring during refuelling.

The complexity of this design, together with the need for enrichment of the uranium, leads to more expensive fuel than that for the current Stage I (magnox) reactors. To offset this increase in fuel cost, a considerable advance in irradiation must be made and a mean irradiation of at least 6,000 MWd/te(U) is the target for the first charge. It is confidently expected that operating experience will enable higher irradiation up to at least 10,000 MWd/te(U) to be achieved.

Graphite Moderator

The behaviour of graphite in contact with carbon-dioxide under the gas temperature and pressure and irradiation conditions of an A.G.R. constituted a major uncertainty at the outset of the project. Available results required considerable extrapolation and, furthermore, the reactions were not fully understood. It could not be said at that time, therefore, that the core would continue to give satisfactory service for the lifetime of the reactor and the reactor was designed so that the graphite core could be replaced, although such a task would involve a major reconstruction of the plant.

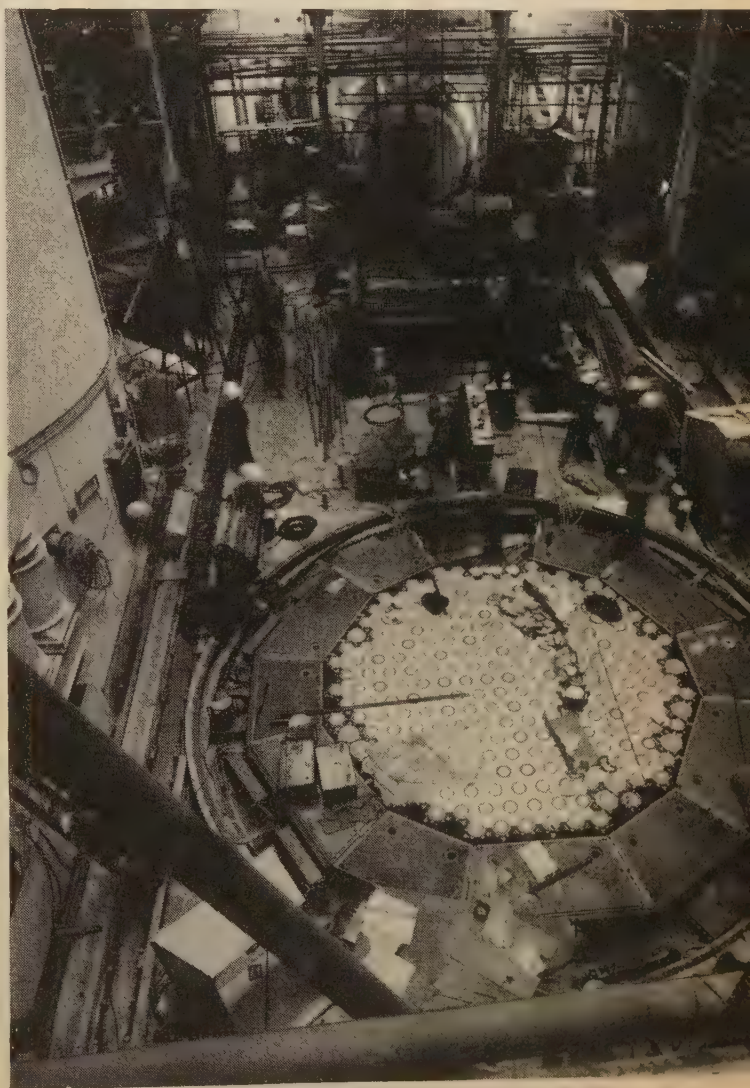
Under irradiation, the carbon-dioxide molecule breaks down and one component of the dissociation is thought to be atoms of oxygen which are chemically reactive and attack the graphite. This reaction manifests itself as a loss of weight of the graphite. Small additions of carbon-monoxide to the coolant reduce this weight loss, either by combining with the oxygen atoms before they

attack the graphite, or by decomposing under irradiation to deposit carbon in the pores of the graphite. Recent results give confidence that the loss of strength of the graphite due to these reactions will be acceptably small.

Irradiation experience on the storage of energy in graphite and the associated dimensional changes is extremely limited at the high temperatures and fluxes of the A.G.R. It is, however, believed that neither of these problems is likely to be serious, and the core has been designed as a solid structure rather than with the form of compensation employed in the Calder Hall reactors.

Reactor Vessel and Contents

The reactor core is supported on a grid within the reactor vessel and is surrounded at its sides by a steel thermal shield. This reduces the degree of embrittlement of the reactor vessel arising from fast neutron damage. The core structure is surmounted by an internal neutron shield necessitated by the compact arrangement of heat exchangers and vessel and by the requirement for core replacement referred to above. It introduces other advantages by reducing the neutron irradiation of the



The refuelling floor of the advanced gas-cooled reactor at Windscale

complex stress regions around the reactor supports and in the vessel head and allows the possibility of external and internal inspection of the upper regions of the reactor when the fuel has been discharged.

There are 253 channels in the core, four of which will contain test loops, while two others are of a larger bore for testing large diameter prototype fuel elements for civil reactors. The remainder will accept fuel stringers, control rods or secondary shut-down mechanisms. Some will be allocated to graphite irradiation specimens.

An interesting feature of the design is that a separate refuelling branch is provided on the vessel head for each channel in the core so that each fuel stringer can be manipulated complete with its shielded plugs and support tubes as a single unit. Instrumentation of the fuel stringer is greatly facilitated. An important advantage of this arrangement in relation to fuel element testing is that the flow of gas through each channel can be controlled by a valve incorporated in the stringer and situated at the level of the outlet manifold. This valve is operated from the refuelling floor while the reactor is on load. This is in contrast to the arrangement on the Calder reactors where a fixed gag is provided at the bottom of each channel—flow adjustment can be made only by replacement of the gag by one of different size following discharge of the fuel in that channel.

The reactor vessel is connected to the four heat exchangers by radial horizontal concentric ducts. Radial expansion of the reactor vessel is allowed by supporting it on rocking struts near the top of the barrel portion at the same level as the ducts. Again at the same level, to form a coplanar system, the heat exchangers are supported on guided balls which permit their radial expansion and bodily movement from the centre of the reactor vessel. Thus a compact arrangement of the major components is achieved.

Heat Removal Plant

A single-pressure steam cycle was adopted since greater emphasis was placed on simplicity and flexibility of operation than on achieving high steam cycle efficiency. Double shell construction was again chosen for the heat

exchangers in which the hot gas flows upwards over the tube banks and the cooled gas downwards along the walls of the vessel. Thus, the superheater is situated at the bottom of the exchanger with the economiser at the top. This arrangement provides a safety feature in that increased circulation by natural convection is available under fault conditions; for emergency purposes cold mains water can be diverted to the economiser.

To dispense completely with the flexible duct system, the circulators were mounted in the bases of the heat exchangers. To avoid the difficulties associated with the design of a high-speed rotating shaft seal for the high-pressure high-temperature coolant, it was decided to enclose the driving motor in a bell connected to the pressure circuit. This converted the sealing problem to one of providing static seals for cables, etc., but it also meant that the driving motor had to be of the simplest design and without commutator or slip-rings. This implied a squirrel-cage induction motor. Rather than provide a variable frequency supply to give speed variation, gas flow control is obtained by adjustment of inlet guide vanes to the centrifugal type impeller. The internal arrangement of the heat exchanger is such that the circulator operates in the cold, and not the hot, gas stream.

Control and Instrumentation

The control and refuelling devices are situated on the top face of the reactor. Control is conventional in design except that the mechanisms are completely housed within the refuelling branches to give a clear floor for traverse of the refuelling machine.

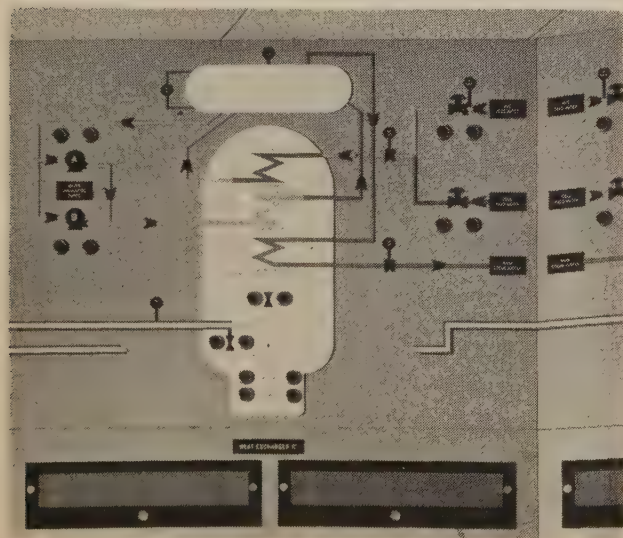
By the inclusion of automatic control, it is hoped to achieve minimum fluctuation of fuel temperature and to avoid a proportion of the spurious trips which might otherwise occur. The control will operate on channel outlet gas temperature and changes in power level will be made by adjustment of the circulator vanes with automatic follow-up on control rod position. The inlet gas temperature will be held constant by the feed water temperature control so that, by holding the outlet gas temperature constant, a steady power level is obtained at constant mass flow.

The safety of the reactor is dependent upon certain operation of the shut-down mechanisms when called upon and, although the shut-off rods are arranged, as is usual, for rapid insertion, a secondary shut-down system has been installed to provide diversity, particularly during the early period of operation.

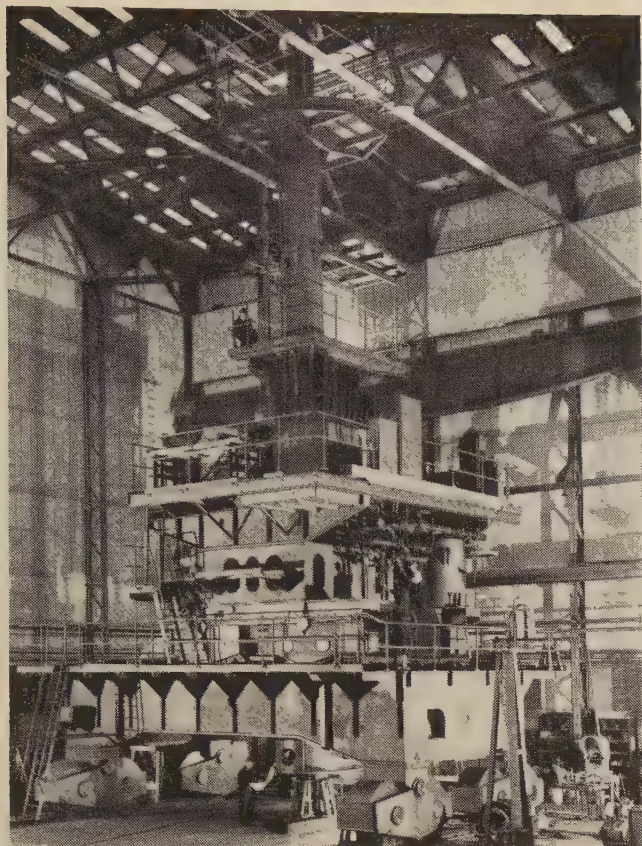
The basic philosophy of the instrumentation scheme is that no measurement is displayed in the reactor control room which is not required for safe operation. Those instruments which produce a historical record or only give general information are mounted close to the relevant plant items. There is more instrumentation than normal because of the experimental nature of the reactor and a data logger is fitted to handle the bulk of the many thermocouple measurements. The minimum number of recorders is provided to keep the reactor running in the event of failure of the data logger.

It was decided to use a matrix system for burst can detection so that all channels are continuously monitored for can failures. Thus a burst, liberating a pulse of fission products of short duration, will be detected.

Irradiated fuel continues to generate heat, although at



The heat exchanger mimic diagram in the reactor control room



Trial assembly of the refuelling machine at the manufacturers' works

a reduced rate, after its removal from the core. An irradiated stringer is therefore withdrawn from the core slowly to allow this heat generation to decay to a convenient level and to avoid severe temperature changes. It is cooled initially by the reactor coolant, but at a later stage the refuelling machine, which has its own coolant circuit and heat rejection system, takes over. The complete stringer is lowered through a lock in the containment building into the carousel, which is a dry storage and cooling magazine which rotates to provide the horizontal transition to the fuel element building. The form of fuel used lends itself to dry storage and cooling rather than storage under water as currently adopted for magnox stations.

Shielding and Containment

Because of the higher ratings in an A.G.R. the coolant activity is such that the heat exchangers have to be lightly shielded. Advantage of this has been taken in the Windscale reactor to make the whole of the primary shielding into an inner, relatively gas-tight, containment. This adds considerably to plant safety at little additional cost.

At the start of design outer containment was specified for the Windscale A.G.R. as a precaution and not from a conviction that it was necessary. It was adopted in view of the experimental nature of the reactor and its close proximity to the U.K.A.E.A. chemical processing plants at Windscale, and it does not follow that A.G.R. power stations must be similarly contained. It was considered that with containment there was less likelihood of limiting the operational flexibility of the reactor.

The provision of an outer containment led to the necessity of installing a ventilation and cooling system to give comfortable working conditions for the operating staff and to dissipate the heat arising from reactor circuit heat losses and irradiation heat in the structure. An integrated system for ventilation, air conditioning and cooling has been devised.

Safety

The safety philosophy for the reactor requires that it shall shut down when called upon to do so, regardless of the effects of any accident. The hazards associated with an A.G.R. are similar to those associated with magnox station reactors, but there is a number of important points of difference. The higher ratings and operating temperatures modify the time scale of some problems, but there are substantially higher margins between operating and can and fuel melting temperatures (as a result of the new materials used), and an absence of substantial exothermic reaction rates involving fuel and can.

A high standard of leak-tightness has been specified, for the pressure circuit, and the cooling and ventilation system has been designed to cope with substantially more than the calculated requirements to maintain satisfactory conditions in working spaces with specified leakage rates and assumptions on corrosion rates.

To cater for the discharge of gas from the reactor, particularly following any accident which might result in discharge of fission products into the coolant, a chemical treatment plant has been installed.

In developing the safety features of the design, particular regard has been paid to those which can be applied in future large reactors without serious impact on economics.

Experimental Programme

The primary purpose of the A.G.R. is to provide statistical data from the irradiation of advanced fuel elements over a wide range of temperatures and ratings. In addition to the ranges that can be covered in the main and experimental channels, which differ in use and not in design, the presence of loops offers further possibilities for tests under more advanced conditions, for irradiation of deliberately defective elements and for controlled coolant composition experiments.

Although the main emphasis will be on the development of a suitable fuel element clad in stainless steel for use in civil versions of the reactor, a proportion of fuel elements clad in beryllium will be studied. Beryllium, having a higher thermal conductivity and lower neutron absorption cross-section than stainless steel, is potentially a better fuel element canning material. However, the gains to be derived from these features are offset by the high cost of manufacture of beryllium components and, in terms of cost per unit sent out, beryllium offers little or no advantage over stainless steel at the present time. If the present difficulties with beryllium in A.G.R. conditions can be overcome economically, this canning material could become important in the future due to the lower total requirements for enriched fuel brought about by the use of beryllium in any large-scale nuclear power programme based on A.G.R.'s.

Information will be derived from the Windscale A.G.R. on the irradiation behaviour of graphite from an extensive

graphite specimen programme, from experiments in the loops where coolant composition can be varied and from experiments with the reactor itself. Provision has been made for irradiating graphite samples in a number of fuel channel holes covering both regular and long-term measurements. Provision is also being made for specimens in fuel assemblies, for specimens in the graphite sleeves, and for sampling both from the sleeves and from the main moderator structure. The facilities required include not only sampling, handling, and examination, but also provision of the necessary accurate temperature measurements. This work is an important section of the operational information expected from the Windscale A.G.R., involving substantial initial expenditure and considerable effort to implement the ensuing development programme.

Provision has been made for extensive flux scanning in the Windscale A.G.R. and sufficiently extensive temperature measurements are being taken to give satisfactory definition of operating conditions. Physics information and kinetic behaviour associated with power levels (through the temperature gradients which are established) can be obtained only from the Windscale A.G.R. itself. If all the physics information for civil A.G.R.'s were to come from the Windscale A.G.R., there would be severe conflict between physics requirements and the necessity for maintaining continuous operation to give desired irradiation levels as quickly as possible. The basic physics work on A.G.R. systems will therefore be obtained from HERO, a low-power high-temperature experimental reactor also being built at Windscale, and the physics programme associated with the start-up of the Windscale A.G.R. will be reduced to the essential experiments necessary for building up to full power operation and to

those experiments which can be carried out only in the Windscale A.G.R. itself.

Development in Other Countries

The United Kingdom is not alone in developing this type of reactor. In the United States of America, the Experimental Gas-Cooled Reactor (E.G.C.R.) is being built at Oak Ridge. This reactor, using helium as coolant, will fulfil a similar role to the Windscale A.G.R. Design studies for A.G.R.'s of 150 MW(E) and 10-15 MW(E) have been carried out in West Germany, and it is possible that a similar reactor of some 30 MW(H) will be built in France under the auspices of Euratom.

Performance of a Civil A.G.R.

A civil A.G.R. station is expected to show a saving in capital cost of about £20/kW over nuclear stations at present being constructed. While the fuel component of generation cost depends upon the irradiation lifetime achieved by the fuel, it is likely that the first civil A.G.R. station will be a distinct improvement over contemporary magnox stations. With development and experience, generation costs of 0.45d/kWh sent out and below can be foreseen.

Conclusion

The Windscale A.G.R. has been built primarily for experimental work associated with the advanced concept of fuel ratings and temperatures. A number of novel engineering features have also been incorporated in the design. Given favourable operating experience and development, it is anticipated that civil versions of the A.G.R. will show a substantial advancement over the present magnox stations.

MAIN BRITISH NUCLEAR POWER CONSORTIA

Consortia	English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Construction Co., Ltd.	Nuclear Power Group	United Power Co., Ltd.
Notes	—	(Was the A.E.I.-John Thompson Nuclear Energy Co., Ltd., and the Nuclear Power Plant Co., Ltd.)	(A merger of Atomic Power Constructors, Ltd., and the G.E.C./Simon-Carves Atomic Energy Group)
Companies	Babcock & Wilcox, Ltd. English Electric Co., Ltd. Taylor Woodrow Construction, Ltd.	Associated Electrical Industries, Ltd. Clarke, Chapman & Co., Ltd. Alex. Findlay & Co., Ltd. Head Wrightson & Co., Ltd. Sir Robert McAlpine & Sons, Ltd. C. A. Parsons & Co., Ltd. A. Reyrolle & Co., Ltd. Strachan & Henshaw, Ltd. John Thompson, Ltd. Whessoe, Ltd.	Fairey Co., Ltd. General Electric Co., Ltd. International Combustion (Holdings), Ltd. Richardsons, Westgarth & Co., Ltd. Simon-Carves, Ltd.
Headquarters	Whetstone, Leicestershire	Radbroke Hall, Knutsford, Cheshire	28/30, Theobalds Road, London, W.C.1.
Contracts	Hinkley Point (Somerset) Sizewell (Suffolk)	Bradwell (Essex) Berkeley (Gloucestershire) Dungeness (Kent) Latina (Italy)	Hunterston (Scotland) Trawsfynydd (North Wales) Tokai-Mura (Japan)
Research Laboratories	Whetstone, Leics. (E.E. Co.) Renfrew (Babcock)	Aldermaston Court (A.E.I.) Newcastle-upon-Tyne (Parsons)	Heston, Middx. (A.P.C., Ltd.) Erith, Kent (G.E.C.)



The Advanced Gas-Cooled Reactor

Technical Description of the £9 Million Windscale Prototype

Designed as the prototype of the "second generation" of civil nuclear power stations, the Windscale advanced gas-cooled reactor will use an enriched uranium dioxide ceramic fuel in stainless steel or beryllium cans and will produce 100 MW of heat, giving a net electrical output of 28 MW. Apart from incorporating the results of development in nuclear technology, many interesting engineering techniques have been employed

TWO years after the commissioning of Calder Hall, the construction of the prototype of the "second generation" of civil nuclear power producing reactors began at Windscale, Cumberland, in October, 1958. It is expected that fuel loading will commence at the end of March next year and full power will be reached five to six months later. This Advanced Gas-Cooled Reactor (A.G.R.) is a logical development from Calder Hall and the magnox civil stations and has, of course, been developed in an effort to reduce the cost of electricity produced as a result of nuclear fission. It is hoped that this will be accomplished by increasing the heat output rating of the fuel and increasing the efficiency with which this heat can be converted to electricity by raising the fuel element surface temperature. In magnox reactors, maximum fuel ratings and temperatures have almost been reached so that for further improvement, a completely new fuel element is required. This is the basis of the A.G.R. design.

The A.G.R. fuel element consists of clusters of thin rods of ceramic uranium dioxide fuel encased in stainless steel or beryllium instead of the single thick rod of natural metallic uranium in a magnox can used in the magnox reactors. Due principally to the greater space taken up by the uranium dioxide, some enrichment of the A.G.R. fuel has been required. The Windscale A.G.R. has been designed as a prototype power producing unit and will be used to determine the performance and burn-up of the new fuel elements, to solve any other outstanding technical problems and to demonstrate the feasibility of the system, including the economics involved in the use of the enriched fuel. The size of the project, 100 MW heat and 28 MW net electrical output, was chosen as the minimum necessary to provide statistical information on the behaviour of fuel elements under operational conditions.

It is expected that the new fuel elements will increase the heat rating of the A.G.R. to over six times the rating of a Calder Hall reactor of the same physical size. In addition, it will be possible to increase the CO₂ cooling

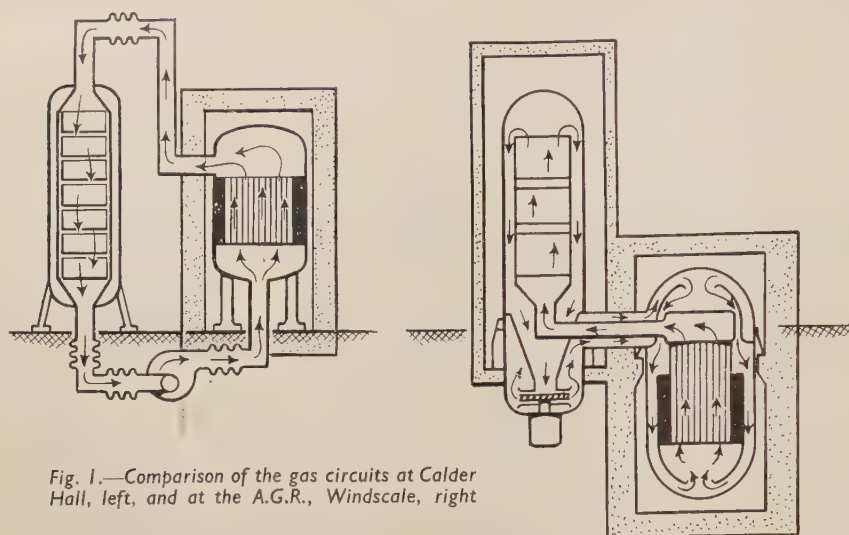


Fig. 1.—Comparison of the gas circuits at Calder Hall, left, and at the A.G.R., Windscale, right

gas temperature by about 200°C compared with Calder Hall. The resulting high cooling gas outlet temperature of an optimised A.G.R. of 575°C ($1,067^{\circ}\text{F}$) would permit the adoption of a modern turbo-generator giving a net station efficiency of over 38 per cent. This compares with the 25-30 per cent obtainable with the magnox stations and gives an increase of almost one-half in the electrical output of the station for the same reactor heat output. These two factors thus combine to give a tenfold increase in the electrical rating compared with a Calder Hall system of the same physical size.

The efficiencies quoted above are based on the useful heat output of the nuclear fuel, which is calculated from the mass flow of the cooling gas and the difference between inlet and outlet gas temperatures. A more accurate assessment of the heat output can be obtained from measurements taken on the steam/water circuit since smaller errors are associated with these measurements. The thermal efficiency of a nuclear power station depends mainly on the efficiency of the steam cycle and, to a lesser extent, on the efficiency of the heat exchangers. The present low outlet gas temperature of the magnox stations has prevented the adoption of high-efficiency high-temperature steam cycles.

Only the technical features of the Windscale A.G.R. are described in this article. Reference to the first article in this issue, by Sir William Cook, will indicate the place of the A.G.R. in the British reactor development programme, while the article by Mr. R. V. Moore describes the philosophy behind the design of the project, the technical difficulties and design problems encountered and the proposed experimental programme. The prospect of the use of the advanced gas-cooled reactor in the future Central Electricity Generating Board's construction programme is considered in Mr. Priest's article. Comments on some of the major points discussed in these articles will be found in our leader pages.

Special Features

The general arrangement and the main engineering features of the A.G.R. can be appreciated from the pull-out coloured graphic illustration facing page 784. From this, it will be seen that the reactor and its four associated heat exchangers, each with their own biological shields,

are enclosed within a pear-shaped steel containment building. Apart from the new type of fuel element, the main feature of the design is the separation of the effects of temperature and pressure in the reactor by the use of double-shell construction. The outer pressure shell of the reactor operates at the cooler inlet gas temperature (250°C at 270 p.s.i.). The inner shell contains the hot gas at reactor outlet temperature (575°C maximum), but is protected by insulation and is subjected only to the differential pressure across the gas circulator (28 p.s.i.). These conditions also apply to the annular ducts between the reactor and its associated heat exchangers and to the heat exchangers themselves.

In the heat exchangers, the hot gas flows up through the superheater to the economiser at the upper end of the heat exchanger. The gas, which has now lost its heat, then flows down between the inner and outer shell of the heat exchanger. A further advantage of this arrangement is that the gas flow through the circuit is the same as that which would occur with natural circulation of the coolant in the event of failure of the main gas circulators.

Another feature of the gas flow circuit is that part of the cool gas entering the reactor is made to flow through passages between the graphite bricks of the core. This ensures that transient variations in fuel temperatures have little effect on the graphite moderator temperature. About 7 per cent of the heat is generated in the graphite, which operates substantially at a steady temperature only slightly



Above: Goods airlock seen from inside the containment vessel

Right: Fig. 2.—Plan of the Windscale site

in excess of that at the inlet to the reactor. The graphite temperature is, however, sufficiently high to prevent the build-up of releasable (Wigner) energy. A comparison of the A.G.R. gas circuit with that at Calder Hall is shown in Fig. 1.

A co-planar support of the reactor vessel and the heat exchangers has been adopted. This feature, which is shown in Fig. 3 and also in Fig. 1 and on the detail on the graphic illustration, eliminates vertical expansion problems and permits the adoption of rigid gas ducts between the reactor vessel and the heat exchangers. Other features of the design are:—(1) The gas circulators and their motors are contained within pressure bells forming extensions to the bases of the heat exchangers; (2) an internal neutron shield is mounted immediately above the graphite core; (3) the thermal shield is contained within the reactor pressure vessel; (4) each channel in the core has a corresponding branch in the head of the reactor vessel; and (5) four experimental loops have been incorporated in the reactor core.

Site Layout

The station consists of the reactor and heat exchanger unit in the containment building, the fuel element building, the turbine hall, the ventilation and chemical plants, and the CO₂ storage and test loop building (Fig. 2). The fuel element building contains the clean fuel element store and the breakdown and inspection facilities for the irradiated fuel. A rotary store, or carousel, for irradiated fuel is situated below ground between the fuel element building and the containment building. On the other side of the containment building is the turbine hall, which also houses the full-load dump condenser and the standby diesel generators.

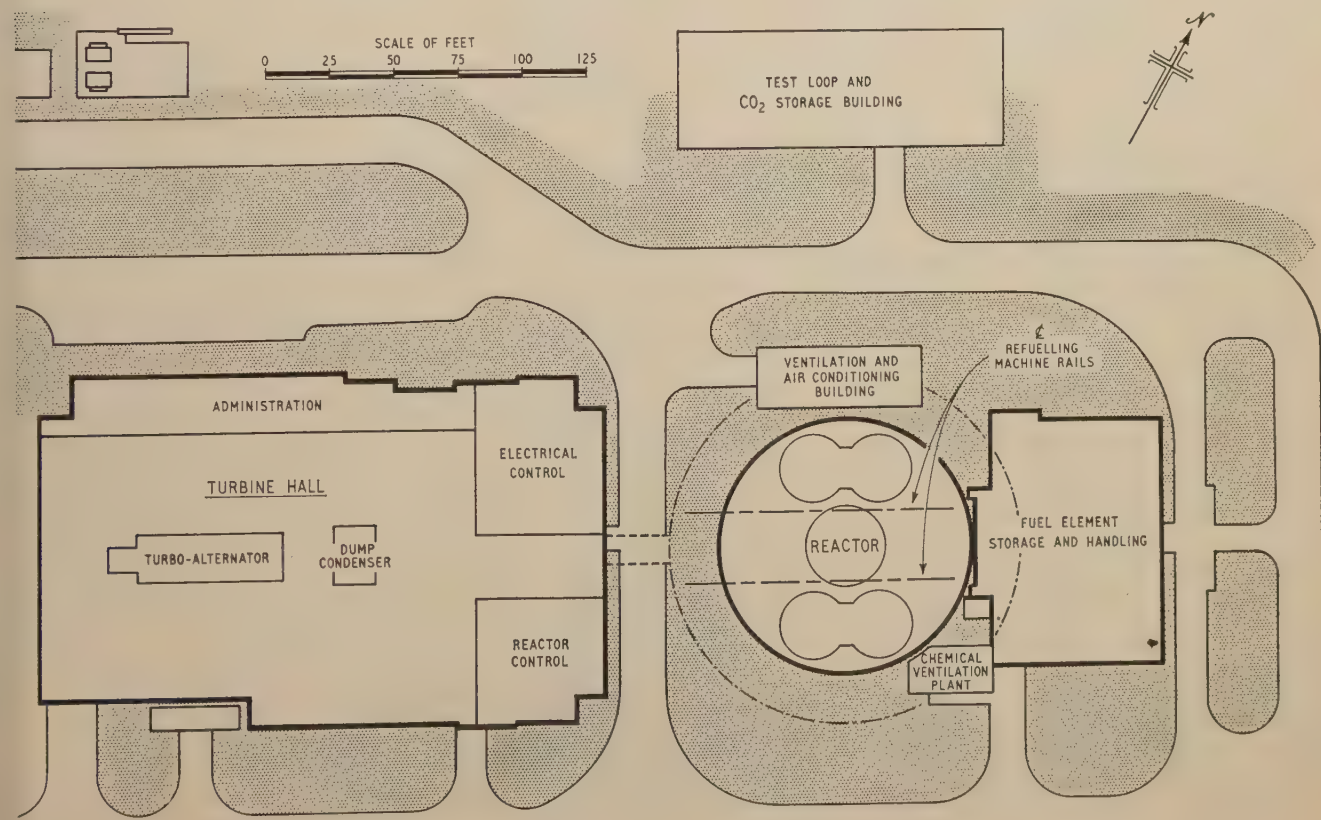
At the north-eastern end of the turbine hall, and integral

with it, is the control block which contains the switch-room; standby batteries; motor-alternator sets for pony motors, instrumentation and control; the main reactor and electrical control rooms; and the change rooms adjacent to the personnel airlock giving access to the containment building. To the south-east of the main site are the induced draught cooling towers associated with the turbines, and to the north-west is the test loop service building, which contains 12 generators for supplying the motors of the test loop circulators. It also contains the batteries for the emergency supply to these circulators. The 132 kV substation is situated to the west of the main site. The siting of the various sections of the project has been arranged so that the station can be duplicated by extending the turbine hall and building another reactor to the south-west.

Containment Building

Because of its experimental nature the reactor is enclosed in a steel containment building. This building consists of a lower conical section surmounted by a hemisphere. It is 76ft 8in in diameter at the base, 135ft in diameter at the equator and the building is 134ft high. The foundations are of heavy reinforced concrete and go down to a maximum depth of 35ft below the ground level.

The main biological shield, which is supported by these foundations, is 30ft in internal diameter, has 9ft thick concrete walls and rises to a height of 70ft. At the top and to the side of this shield are four heat exchanger containments, each of 21ft internal diameter with 2ft thick concrete walls. They extend a further 50ft above the main biological shield. As already mentioned, the reactor vessel and the heat exchangers are supported at the same level. This arrangement forms a double cantilever in



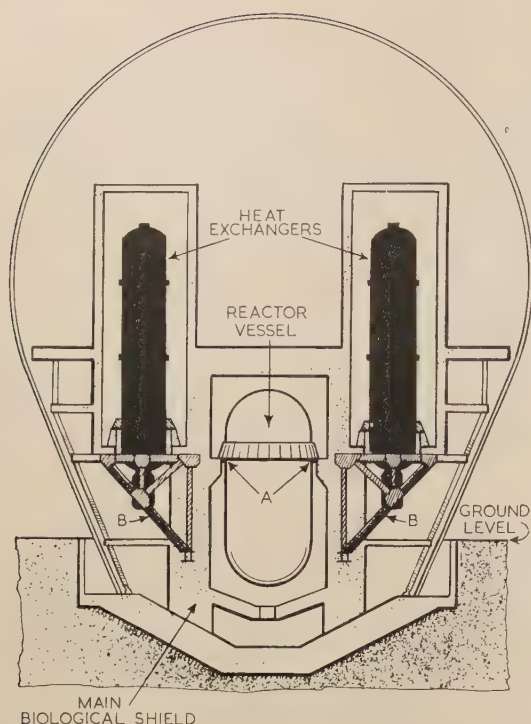


Fig. 3.—Cross-section of the containment building showing the co-planar structural supports. A—reactor supports, B—out-rigger frames carrying the weight of the heat exchangers on to the main biological shield

which the weight of the reactor vessel balances the weight of the four heat exchangers (Fig. 3).

The steel containment building has been designed to contain the entire contents of the reactor pressure circuit in the unlikely events of a breach in the latter and the failure of a heat exchanger tube. It is designed for an internal pressure of 10 p.s.i. and it was tested last August to 12.75 p.s.i. It was also leak-tested to ensure that the leakage during 24 hours was below 0.1 per cent of the

volume. The building was constructed from a number of shaped courses of boiler plate varying in thickness from $1\frac{1}{8}$ in in the base of the conical portion to $\frac{1}{2}$ in in the hemispherical dome. These plates were butt-welded together at site and were completely radiographed.

The containment building is thermally insulated externally by a $1\frac{1}{2}$ in thick layer of polystyrene, which has been covered with 20 gauge aluminium sheeting. The aluminium is fixed by stainless steel setscrews to studs protruding from the steel shell of the containment building at 2 ft 6 in centres.

Separate airlock entrances to the containment building are provided for the passage of personnel between the refuelling floor and the control room annexe of the turbine hall and for the passage of goods at ground level. An emergency exit over the fuel element building at refuelling floor level has also been provided. There are separate airlocks for the passage of clean and irradiated fuel element stringers (Fig. 4).

Under operating conditions, the containment building is pressurised by the air-conditioning plant to about 17 in of water. If the pressure should rise above this figure, the inlet and outlet air-conditioning valves are closed and the containment vessel is isolated. This pressurised system within the containment building is divided into the inner and outer zones. The inner containment includes the reactor vessel and heat exchangers, while the outer zone comprises the normal working areas outside the biological shields. Flap valves have been provided in the biological shield at the top of the heat exchangers and these will operate at 5 p.s.i.g. A minor leak should, therefore, be contained within the inner circuit, but if the pressure exceeds 5 p.s.i.g., the flap valves will blow to prevent cracking of the concrete. Operation of the flap valves is controlled by a shear pin.

Fuel Elements

The high temperatures and fuel ratings in the A.G.R. are achieved by the adoption of ceramic-enriched uranium dioxide as the fuel and stainless steel or beryllium as the

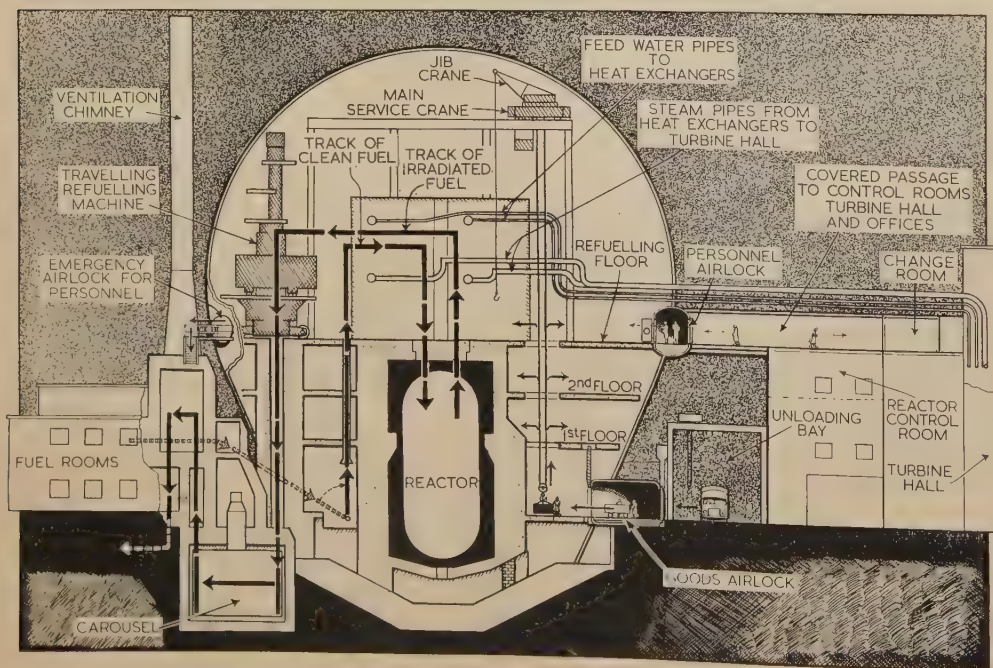


Fig. 4.—Various entrances and exits to the containment building are shown in this diagrammatic arrangement. These include personnel, goods and fuel airlocks and steam and water connections

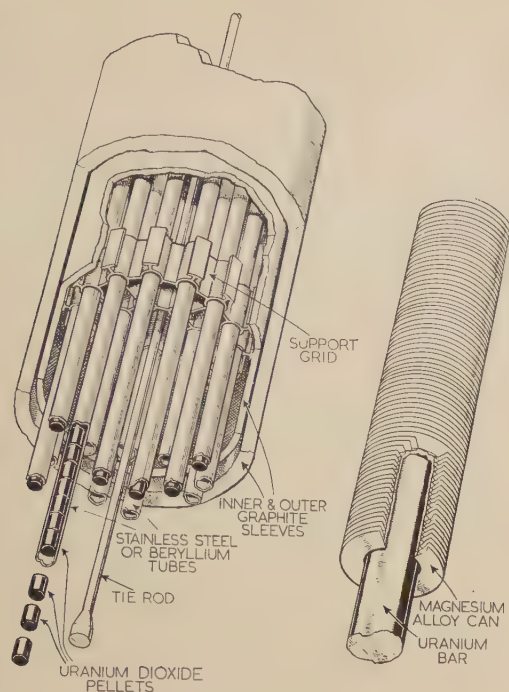


Fig. 5.—Comparison of the fuel elements for Calder Hall, right, and the A.G.R., left

canning material. The average fuel rating is 8.9 MW/te and the maximum rating 19.5 MW/te. It is expected that irradiation substantially in excess of 6,000 MWd/te will be obtained. The total weight of fuel in the reactor is 13.2 tonnes. The designed operating surface temperature of the stainless steel cans is 650°C ($1,202^{\circ}\text{F}$).

The bulk of the first fuel charge of the A.G.R. will consist of stainless steel canned elements. Until the problems associated with beryllium under the high temperature conditions in the A.G.R. have been solved, only a few beryllium-clad elements will be loaded into the cooler parts of the reactor.

A typical fuel element is shown in Fig. 5 and is compared with a Calder Hall element. A complete fuel element stringer comprises four 3ft long sub-assemblies, each contained in a 5in outside diameter graphite sleeve. These sub-assemblies are linked together giving a complete fuel stringer 50ft long with a 14ft fuel section.

Each of the stainless steel canned sub-assemblies consists of two 18in long clusters of stainless steel fuel element rods arranged end to end. Each cluster consists of twenty-one 0.43in diameter rods with 0.015in wall thickness. Each rod contains a quantity of 2.5 per cent enriched uranium dioxide pellets 0.4in in diameter by 0.4in long in an atmosphere of helium. The beryllium design is similar, except that there are 36 fuel element rods per cluster, each rod is 0.38in in diameter with 0.04in wall thickness and 12in long, and the 1.8 per cent enriched fuel pellets are 0.3in in diameter by 0.3in long. There are three such clusters per beryllium fuel element sub-assembly. A complete stringer weighs approximately 1,000 lb.

In each design, the four sub-assemblies are held together by a central stainless steel tie rod connected to the lower end of the neutron shield plug. A sleeve valve at the outlet gas manifold level allows individual flow control.

These valves are adjustable from the refuelling floor with the reactor at pressure.

Fuel Handling

Clean fuel is unloaded and assembled in the fuel handling building, adjacent to the containment building. The clean fuel entry is shown in the bottom left-hand side of the graphic illustration and also in Fig. 4. Clean fuel is removed from the transport cases by overhead cranes and deposited on to an assembly bench. The sub-assemblies are then transferred to another bench where these individual sections are connected and strapped to a stainless steel tray. The complete stringer tray is pushed through an airlock into the containment building until pinions on the tray engage with lugs on the chain conveyor. This takes the tray through the airlock inner door to a second conveyor until a final track limit switch stops the tray in a position ready for elevating. The second conveyor is hinged at its lower end. The stringer, conveyor and tray are then elevated through 60° into the vertical position

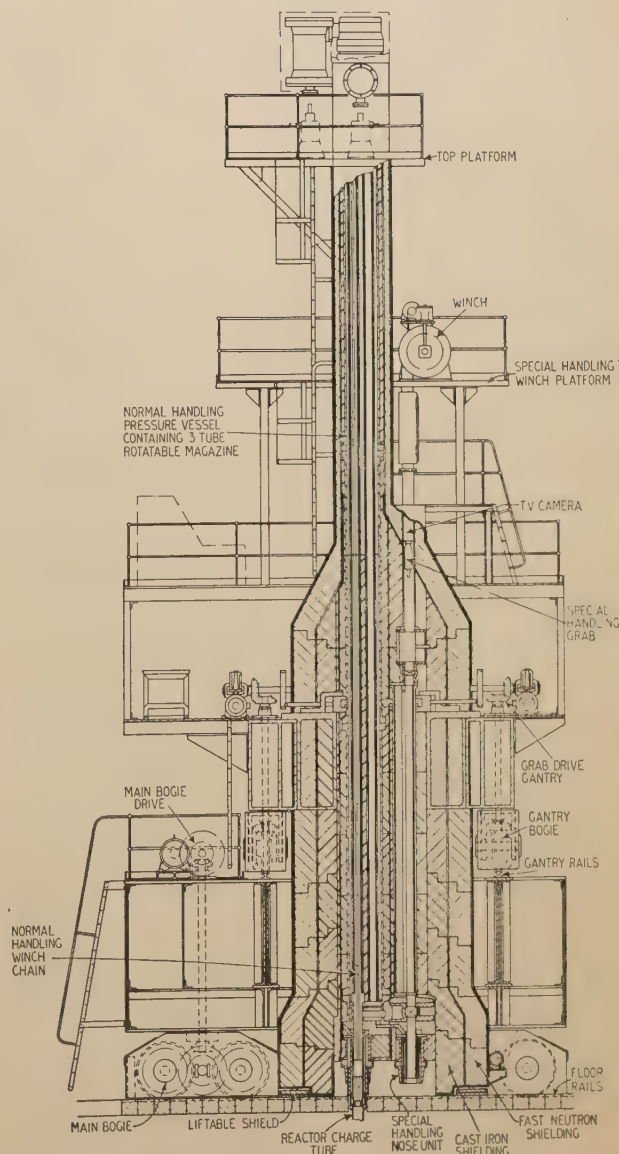


Fig. 6.—Cross-section of the 400 ton 65ft high refuelling machine. Access to the nose unit is gained by pneumatically operated doors which form part of the lower shielding

whence the stringer is hoisted to refuelling floor level where the top section is connected.

The reactor is refuelled on load by a single refuelling machine (Fig. 6) which is capable of removing and replacing three fuel element stringers per 24 hours at full reactor pressure. The machine also handles the control rods, emergency shut-down devices, and graphite sampling equipment and services the test loop systems. This combined charge/discharge machine is 65ft high and weighs 400 tons. It consists of a normal handling pressure vessel, a special handling pressure vessel, a gantry which enables the machine to travel along the reactor floor and a crab which allows the machine to traverse the gantry. The machine also contains its own cooling and purge system, the designed temperature of most parts of the refuelling machine being 325°C.

The normal handling pressure vessel contains a three-compartment rotating magazine for clean fuel, irradiated fuel, and a standby reactor seal plug, respectively. It is designed for a pressure of 500 p.s.i.

The special handling facility can be used only when the reactor is shut down. Designed to operate at 25 p.s.i., this vessel also contains a rotating magazine with three compartments. These compartments house a television camera and various grab tools. Both the normal handling and special handling pressure vessels are shielded against gamma and fast neutron radiation involving some 200 tons of cast iron and laminated wood.

The gantry is driven by two 5 h.p. d.c. motors. The motors operate at 1,500 r.p.m. and drive the gantry at a maximum speed of 10ft/min via a comprehensive gear train which has a minimum of backlash. The crab is driven by two 2 h.p., 1,000 r.p.m. d.c. motors. The maximum traversing speed of the crab is 4ft/min. The diamond-shaped trunking on the side of the machine allows the electrical connections between the drive motors and the control platform to be of constant length regardless of the position of the crab (see the graphic illustration).

The movement control system of the refuelling machine is such that it will travel the full floor width of the containment building and position itself to within 0.005in of any of the 253 reactor refuelling branch pipes. Coarse control of the movement of the machine is based on a Magslip. This control will position the machine with an accuracy of $\frac{1}{2}$ in. The nose unit is then lowered over the standpipe. A sensing head is incorporated in the nose unit and consists of a ring of a larger diameter than the standpipe. Switches fitted to the internal wall of the ring are physically actuated if the standpipe is off centre. These switches operate potentiometers, which in turn, control the fine movement of the machine until the ring is centred and all switches are out of physical contact with the standpipe.

Each channel in the core has a corresponding branch in the head of the reactor vessel. This allows the complete stringer of fuel element assemblies and shield plugs to be withdrawn as a single unit, thus eliminating the necessity for remote operation of grabs and internal latching devices. It also facilitates instrumentation; up to seven thermocouples may be installed in each channel.

After the machine has been positioned, the shielding doors are opened and the reactor plug is manually connected to the machine. The operator then leaves the machine and closes the shielding doors. The nose unit

is extended from either the normal or the special pressure vessel and a seal is effected between the machine and the reactor. If the reactor is to be refuelled, the normal pressure vessel is then purged and pressurised with clean CO₂. The reactor plug, to which is connected the fuel stringer, is then hoisted at 1ft/min into one of the three magazine compartments. The magazine is rotated and the clean fuel plug string is lowered, also at 1ft/min, and locked into the reactor. The nose unit is purged with air and retracted. The shielding doors are opened and the reactor plug disconnected from the hoisting mechanism.

Carousel

Spent fuel is discharged from the refuelling machine into one of three spent fuel chutes and lowered into the carousel where the activity is allowed to decay for several months. There is no cooling pond because of possible chemical action between water and fuel canning materials.

The carousel or spent fuel store consists of a 25ft 6in diameter drum which has 420 storage tubes arranged on three concentric circles corresponding to the three spent fuel tubes from the refuelling floor. The carousel, which weighs 60 tons empty and 140 tons when fully loaded, is supported on a spherical roller bearing and can be rotated by an electric motor through a variable-speed gear unit to give an inching peripheral speed of 6in/min. A semi-automatic electrical control system can position the rotor so that any storage tube in the carousel can be lined up with any transit chute tube on that particular pitch circle.

The carousel is contained within a 27ft internal diameter, 21ft 6in high vessel constructed of $\frac{3}{8}$ in thick steel plate. This vessel can withstand internal or external pressures of 2 p.s.i. and has a cooling system designed to remove 568 kW of heat from the fuel. Three coolers are provided for the CO₂ which is circulated through and around the fuel element stringers in the carousel. The maximum designed gas outlet temperature is 370°C. Filters have been provided to extract any dust particles in the circuit. Three centrifugal blowers are provided, one driven by an a.c. motor and two by standby d.c. motors.

There are two sets of three-exit tubes from the carousel, each set leading to a breakdown "cave." Spent fuel is removed from the carousel through one of these tubes by an overhead crane into one of the two caves where it is metallurgically examined. The fuel stringer is broken down into its sub-assemblies which are then transferred by a manipulator to a "coffin" for transport away from the site.

If the fuel cannot be inserted into the carousel because of temporary blockage or because of the high activity from a failed can, then a "mortuary tube" is used to store the complete fuel element stringer which has been moved from the reactor. There are ten 8in diameter steel mortuary tubes, each 52ft long, situated vertically in the concrete of the biological shield. The fuel elements are continuously cooled by CO₂ flowing through the mortuary tubes in a closed circuit at a slight pressure above atmospheric.

Reactor

The 250 ton pressure vessel is a vertical cylinder with hemispherical top and bottom ends and measures 21ft 3in in mean diameter and is 53ft 6in long over the ends. Since a standpipe has been provided for every channel

ADVANCED GAS-COOLED REACTOR AT WINDSCALE

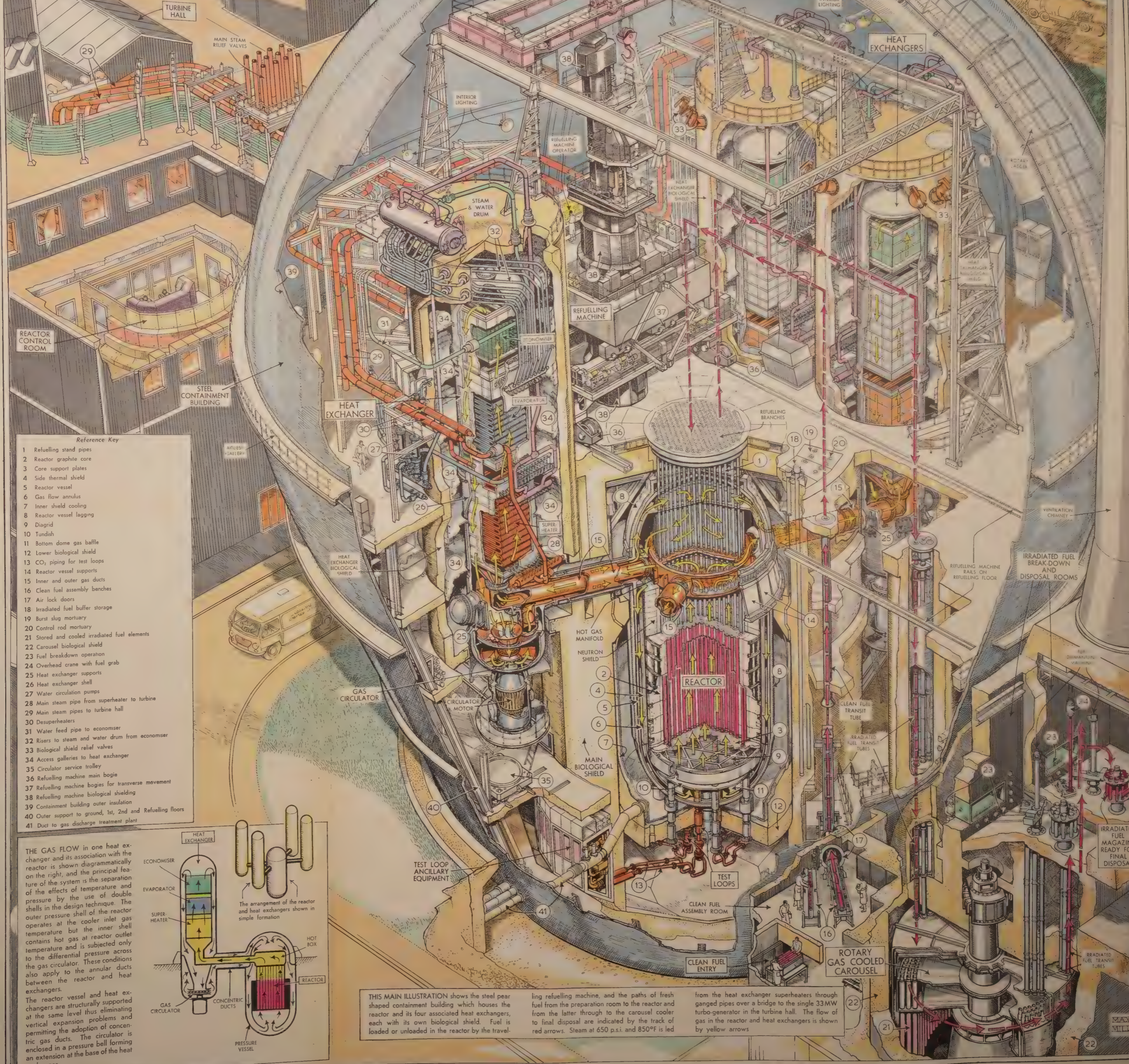
Prototype of the next series of British civil nuclear power stations, designed to use enriched ceramic fuel. The reactor is rated at 100 MW (heat) giving a net electrical output of 28 MW. Construction began in 1958

GRAPHIC ILLUSTRATION PREPARED BY
MAX MILLAR AND THE TECHNICAL STAFF OF
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ELECTRICAL
REVIEW

ADVANCED
GAS-COOLED
REACTOR AT
WINDSCALE

Perforated for
easy removal

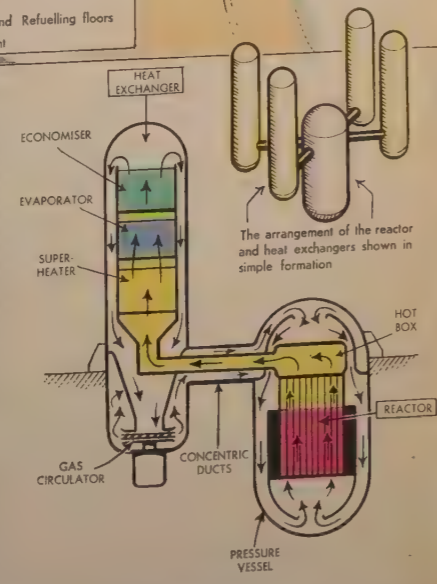


Reference Key

- 1 Refuelling stand pipes
- 2 Reactor graphite core
- 3 Core support plates
- 4 Side thermal shield
- 5 Reactor vessel
- 6 Gas flow annulus
- 7 Inner shield cooling
- 8 Reactor vessel lagging
- 9 Diagrid
- 10 Tundish
- 11 Bottom dome gas baffle
- 12 Lower biological shield
- 13 CO₂ piping for test loops
- 14 Reactor vessel supports
- 15 Inner and outer gas ducts
- 16 Clean fuel assembly benches
- 17 Air lock doors
- 18 Irradiated fuel buffer storage
- 19 Burst slug mortuary
- 20 Control rod mortuary
- 21 Stored and cooled irradiated fuel elements
- 22 Carousel biological shield
- 23 Fuel breakdown operation
- 24 Overhead crane with fuel grab
- 25 Heat exchanger supports
- 26 Heat exchanger shell
- 27 Water circulation pumps
- 28 Main steam pipe from superheater to turbine
- 29 Main steam pipes to turbine hall
- 30 Desuperheaters
- 31 Water feed pipe to economiser
- 32 Risers to steam and water drum from economiser
- 33 Biological shield relief valves
- 34 Access galleries to heat exchanger
- 35 Circulator service trolley
- 36 Refuelling machine main bogie
- 37 Refuelling machine bogies for transverse movement
- 38 Refuelling machine biological shielding
- 39 Containment building outer insulation
- 40 Outer support to ground, 1st, 2nd and Refuelling floors
- 41 Duct to gas discharge treatment plant

THE GAS FLOW in one heat exchanger and its association with the reactor is shown diagrammatically on the right, and the principal feature of the system is the separation of the effects of temperature and pressure by the use of double shells in the design technique. The outer pressure shell of the reactor operates at the cooler inlet gas temperature but the inner shell contains hot gas at reactor outlet temperature and is subjected only to the differential pressure across the gas circulator. These conditions also apply to the annular ducts between the reactor and heat exchangers.

The reactor vessel and heat exchangers are structurally supported at the same level thus eliminating vertical expansion problems and permitting the adoption of concentric gas ducts. The circulator is enclosed in a pressure bell forming an extension at the base of the heat exchanger.



THIS MAIN ILLUSTRATION shows the steel pear shaped containment building which houses the reactor and its four associated heat exchangers, each with its own biological shield. Fuel is loaded or unloaded in the reactor by the travel-

ling refuelling machine, and the paths of fresh fuel from the preparation room to the reactor and from the latter through to the carousel cooler to final disposal are indicated by the track of red arrows. Steam at 650 p.s.i. and 850°F is led

from the heat exchanger superheaters through ganged pipes over a bridge to the single 33 MW turbo-generator in the turbine hall. The flow of gas in the reactor and heat exchangers is shown by yellow arrows

in the core and due to the hemispherical shape of the top dome of the vessel, the 253 $6\frac{1}{2}$ in i.d. standpipes arranged on a $10\frac{3}{4}$ in triangular lattice are confined to a 15ft diameter circle. The radius at which standpipes can be fitted is limited by the acute angle of the penetration and the consequent welding difficulties. This causes a corresponding limitation in the size of the core, and at Windscale the space between the outside of the core and the inside of the pressure vessel has been utilised by the incorporation of a thermal shield.

As already mentioned, the double-shell construction is a feature of the design of the reactor system which allows for the separation of the effects of temperature and pressure. Other advantages resulting from the position of the thermal shield within the reactor include the reduction of the irradiation of the vessel and the obviation of cooling problems associated with the normal position of thermal shields between the reactor vessel and the concrete biological shielding.

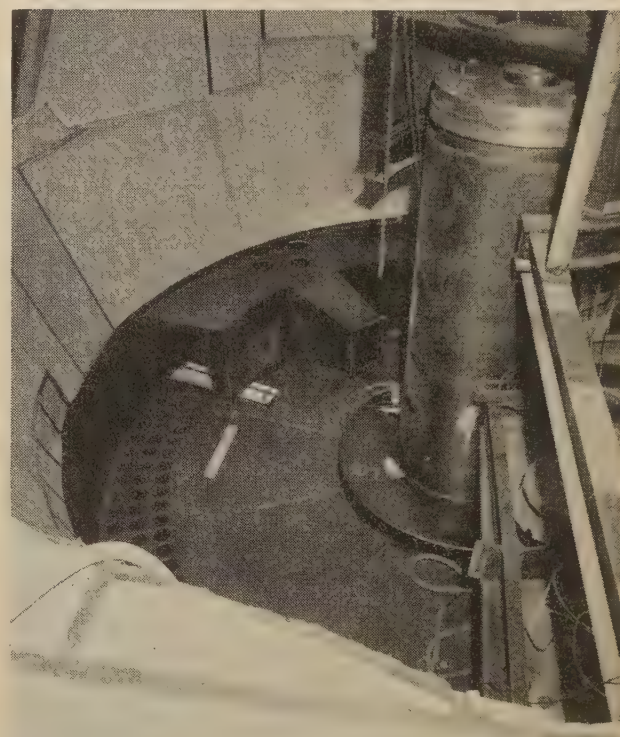
The vessel has been made from silicon-killed aluminium grain-controlled mild steel (Conlo 1). The working pressure of the system is 270 p.s.i. compared with 100 p.s.i. for the larger Calder vessels so that, although the Windscale vessel is smaller, it requires the use of $2\frac{7}{8}$ in thick plates in its cylindrical or barrel portion, compared with 2in thick plates at Calder. The barrel is constructed in five strakes, each $2\frac{7}{8}$ in thick, except for the top strake to which the structural supports and gas ducts are attached. This strake is $3\frac{1}{4}$ in thick, but in the vicinity of the gas ducts it is $4\frac{3}{8}$ in thick. To withstand pressure alone, the hemispherical ends of the vessel would have been only $1\frac{1}{4}$ in thick, but because of the concentration of standpipes in the top dome, the region where these openings occur is in $3\frac{1}{2}$ in plate. The bottom dome carries the weight of the graphite core on 12 supports and also has six nozzles for the test loops and six viewing tubes. It has therefore been constructed of $2\frac{1}{4}$ in thick plates.

The diagrid support for the graphite core is mounted on rocker supports to brackets in the bottom of the vessel. The base plates sit on levelling screws on top of the diagrid and the graphite columns are supported by ball bearings from the base plates. It is expected that the temperature of the graphite core will be about the cross-over point between shrinkage and growth and it has been designed to allow for a limited amount of growth or shrinkage. The 210 ton graphite core is 15ft in diameter and 14ft high and has 253 main fuel channels arranged in a $10\frac{3}{4}$ in triangular pitch. The reflector is 20in thick radially and 24in thick axially. The main fuel channels and two test loops can accept 5in diameter stringers. The two other test loops are somewhat smaller, while two core channels, which will be used for testing civil A.G.R. fuel elements, are $6\frac{1}{2}$ in in diameter. The size of these channels was limited by the size of the largest nozzle which could be attached to the dome without causing ligament deficiency. The lattice pitch of $10\frac{3}{4}$ in for the standard 7in o.d. nozzles leaves only $3\frac{3}{4}$ in between nozzles.

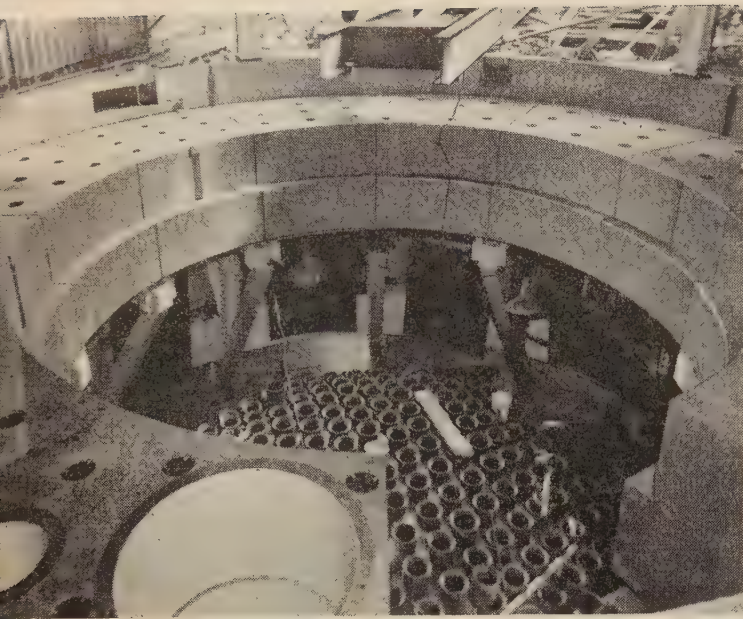
Cool inlet gas channels have also been provided in the graphite core (Fig. 7). This is one of the special features mentioned previously and has been incorporated in the design to ensure that transient fuel and coolant temperature variations have little effect on the graphite core. This re-entrant principle reduces the temperature swing of the graphite and will, therefore, reduce the reactivity effect



View of the refuelling machine above the pile-cap



The carousel radiated fuel storage unit



The dome of the reactor vessel can be seen below the top biological shield

due to positive temperature coefficient which is caused by the build-up of plutonium. (Plutonium has a peak in its fission cross-section at energies just above the neutron thermal energy. The energy level of the neutrons is, of course, dependent on the temperature level of the moderator. Therefore an increase in moderator temperature can produce an increase in fission rate. In the early stages of operation when only a small amount of plutonium has been formed, an increase in temperature would, in fact, reduce reactivity.)

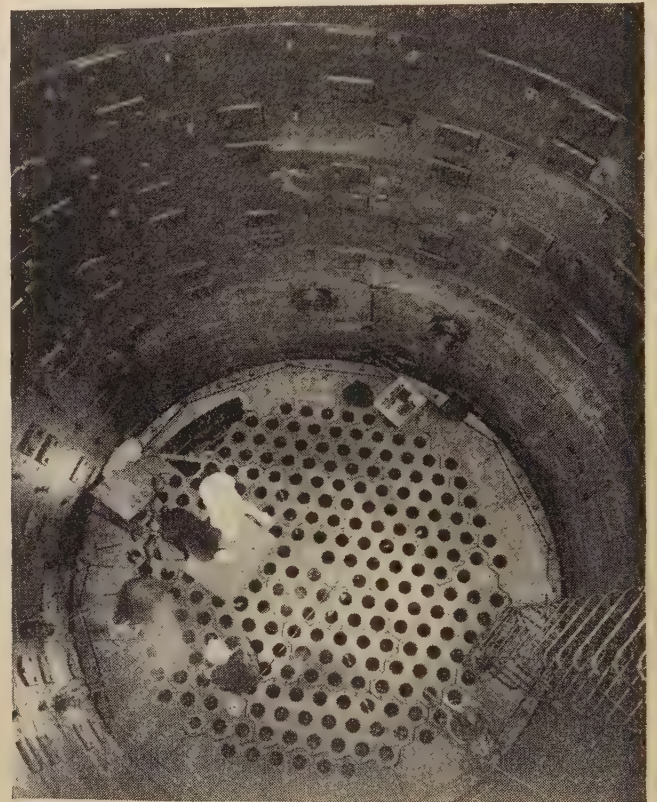
An internal neutron shield is placed above the graphite core within the pressure vessel. This reduces the thickness of the biological shield above the reactor vessel and prevents neutrons streaming along the ducts. It also



Standpipe extensions from the top of the pressure vessel to the charging floor

allows access on shutdown to the outside of the upper shell of the reactor vessel for inspection and maintenance purposes and also to the inside, if the fuel is removed. If the core has to be changed at any time, it is feasible to cut off the head of the pressure vessel and take out the core by remote handling equipment. The shield is 7ft thick and consists of layers of graphite and boron steel which respectively thermalise and absorb the neutrons emitted from the core.

As already mentioned, a side thermal shield has been included within the reactor vessel. It is constructed of three interlocking layers of 2in thick steel plates forming a structure 6in thick. Top and bottom thermal shields are also provided. As the hot outlet gases emerging from the core of the reactor are at too high a temperature to permit their impinging upon any part of the pressure



Reactor vessel with thermal shield and support plates in position

shell, it has been necessary to introduce a cylindrical collector box above the core into which the outlet gases flow. This hot box is of mild steel construction and lined with stainless steel insulation and is perforated by 253 holes which carry the standpipe ducting down to the fuel channels. It has been designed to withstand the differential pressure between the inlet and outlet gases of about 30 p.s.i. The hot gas from the fuel channels passes into the hot box via ports in the tubes running through the hot box. These ports line up with the sleeve valves in the fuel element stringers. Hot gases from this collector box pass out of the vessel through four 1ft 1in diameter carbon steel internally insulated ducts which pass concentrically inside the 2ft 10in diameter ducts carrying the cool gas back to the vessel.

The reactor gas outlet temperature is 500-575°C, and the inlet temperature is 250-325°C. The weight of gas in the complete gas circuit is about 14 tons and the rate of circulation through the reactor is 760 lb/sec or about 20 tons/min.

Heat Exchangers

As we have said, a co-planar support of the reactor and heat exchangers has been adopted which eliminates vertical expansion problems. Radial expansion between the reactor and heat exchanger is taken up by ball bearings which support the heat exchangers. There is, however, a slight differential expansion between the inner and outer portions of the annular ducts between the vessel and the heat exchangers. This is taken up by a sliding joint on the inner hot gas duct at the heat exchanger end. Leakage at this joint is eliminated by a bellows arrangement. Since the A.G.R. has a higher rating and pressure than Calder Hall, the radioactivity in the cooling gas is higher; consequently biological shielding has been placed around the heat exchangers.



Bottom sections of a heat exchanger being lifted into the containment building



The face of the reactor floor

Each of the four heat exchangers is of double-shell construction and the flow of gas is shown in Fig. 1. Each exchanger is rated at 25 MW (heat) and is capable of generating 78,350 lb/hr of steam at 660 p.s.i. and 860°F after the desuperheater. The 1 $\frac{7}{8}$ in thick outside shell of each exchanger is 11 ft in diameter and 67 ft 9 in high. It houses the economiser at the top, the evaporator in the centre and the superheater at the base with a centrifugal gas blower mounted in the bottom end.

The total heating surface of each exchanger is 47,000 sq ft. The economiser and evaporator sections are manufactured from 2 in o.d. mild steel tubing with $\frac{1}{2}$ in high helical fins welded externally with six fins per inch. The superheater elements are manufactured from 2 $\frac{1}{4}$ per cent chrome/1 per cent molybdenum tubing. There are no fins on the superheater tubing. The steam drum is

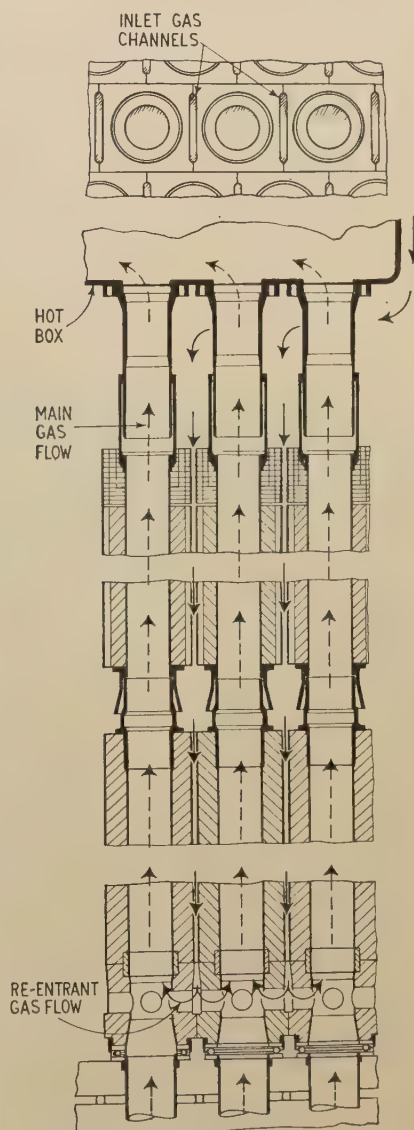


Fig. 7.—Section through the graphite core showing gas flow

situated on the top of the concrete shielding above the heat exchangers.

Gas Circulators

Fig. 8 is a cross-section through a gas circulator and its associated motors. Each one of these units is enclosed in a pressure bell at the bottom of its heat exchanger. This eliminates the necessity for a rotating gas seal. Each circulator is driven by a 1,570 h.p., 3,000 r.p.m., 3.3 kV squirrel-cage induction motor or, alternatively, by a 40 h.p. variable-frequency pony motor, fed from a guaranteed supply (motor-alternator sets supplied from batteries or diesel generators). Both motors are mounted on the same shaft and are cooled by water coils.

Mass flow control of the reactor coolant is obtained by variable-pitch guide vanes at the inlet to the single-speed centrifugal type gas blower. The blowers are rated at 200 lb/sec of CO_2 with a pressure head of 28 p.s.i.

Steam/Water Circuit

Water from the feed pumps in the turbine hall flows through 12 pipes, situated above the walk-way between the reactor containment vessel and control block (Fig. 4) to the economisers in each of the four heat exchangers in the containment building. From the economiser, the water goes through eight pipes into the steam/water drum which is situated on top of the heat exchanger concrete shield (Fig. 9). From here the water is circulated by pumps, which are at pile cap level, through the evaporator and back into the drum as steam. The steam in the drum then passes to the top of the superheater which is situated at the bottom end of the heat exchanger. Two steam pipes from each heat exchanger superheater carry the live steam to the turbine hall. Desuperheaters are fitted in each pipe

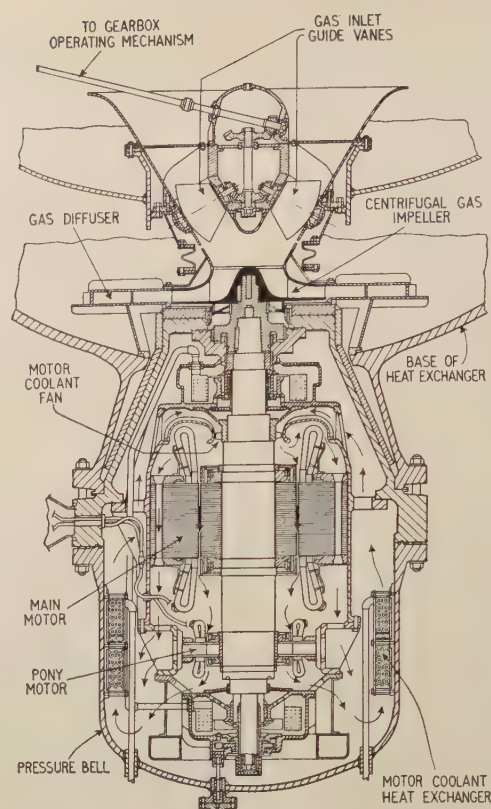


Fig. 8.—Cross-section through a gas-circulator which is driven by a 1,570 h.p. 3.3 kV induction motor. One of these circulators is enclosed in a pressure bell at the bottom end of each heat exchanger

near its associated heat exchanger. The eight steam pipes from the heat exchangers in the containment building to the turbine hall are situated above the water pipes on the walk-way between the control block and the containment building.

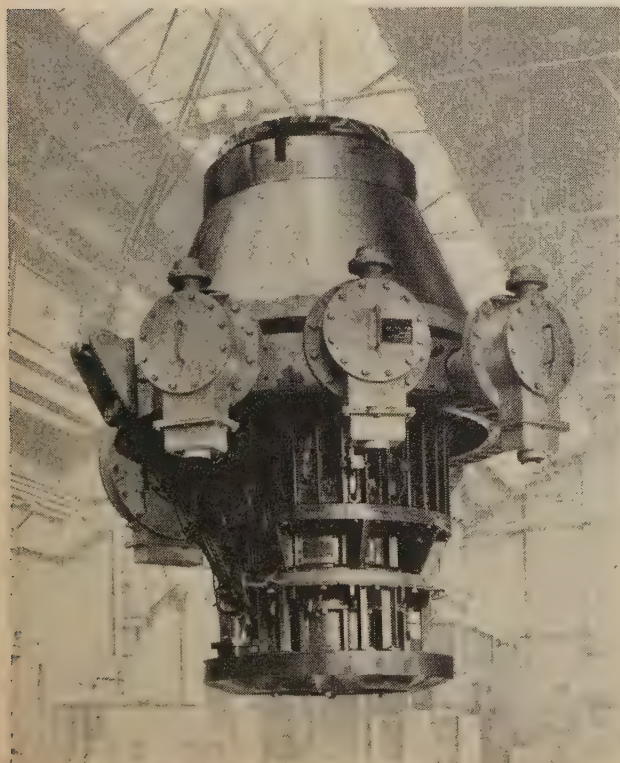
Turbo-Generators

Steam conditions at the turbine stop valve are 650 p.s.i. and 454°C (850°F). A 900 p.s.i., 900°F system would have been possible and this would have allowed the use of a modern conventional turbo-generator. But because of the experimental nature of the project, it was decided that the lower-pressure system adopted would be more flexible. The single 33 MW turbo-generator operates at 3,000 r.p.m. and generates at 11.5 kV. The turbine is of standard two-cylinder design with a single-flow h.p. impulse cylinder. The l.p. cylinder is of the double-flow reaction type with the exception of the first stage in each flow which is of the impulse design. The vacuum at continuous maximum rating is 28.6 in Hg, with a nominal final feed temperature at 350°F.

The alternator is a standard air-cooled machine with separate motor-driven fans. Excitation is provided by a totally enclosed air-cooled exciter driven from the tail shaft of the alternator through a flexible coupling. It uses magnetic amplifier automatic voltage regulators.

There are four stages of bled steam feed heating comprising one l.p. heater, two 50 per cent high level de-aerators and two banks of h.p. heaters, both of which are arranged with two 50 per cent heaters.

The h.p. heaters are suitable for heating feed water by means of live steam from the heat exchangers as an alterna-



One of the four 1,570 h.p. motors for driving the CO_2 circulators

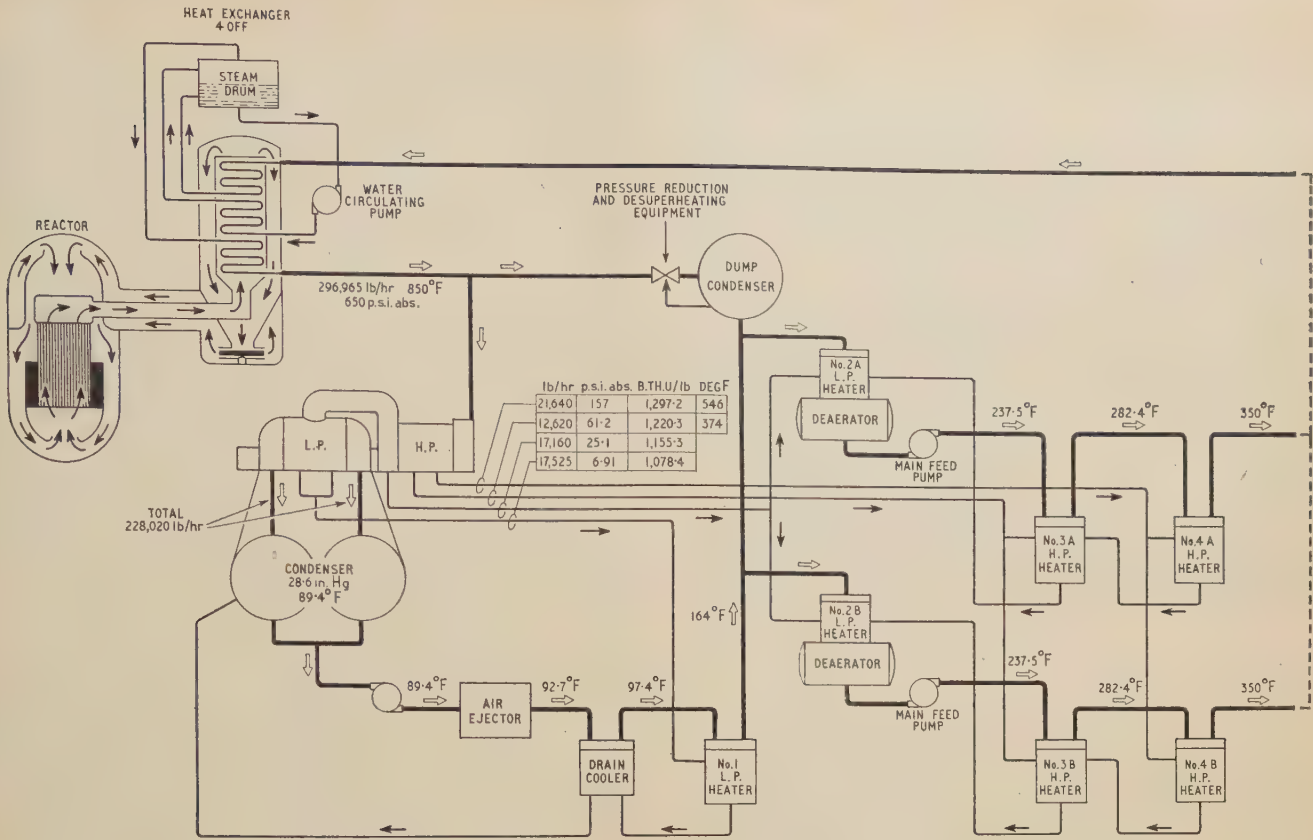
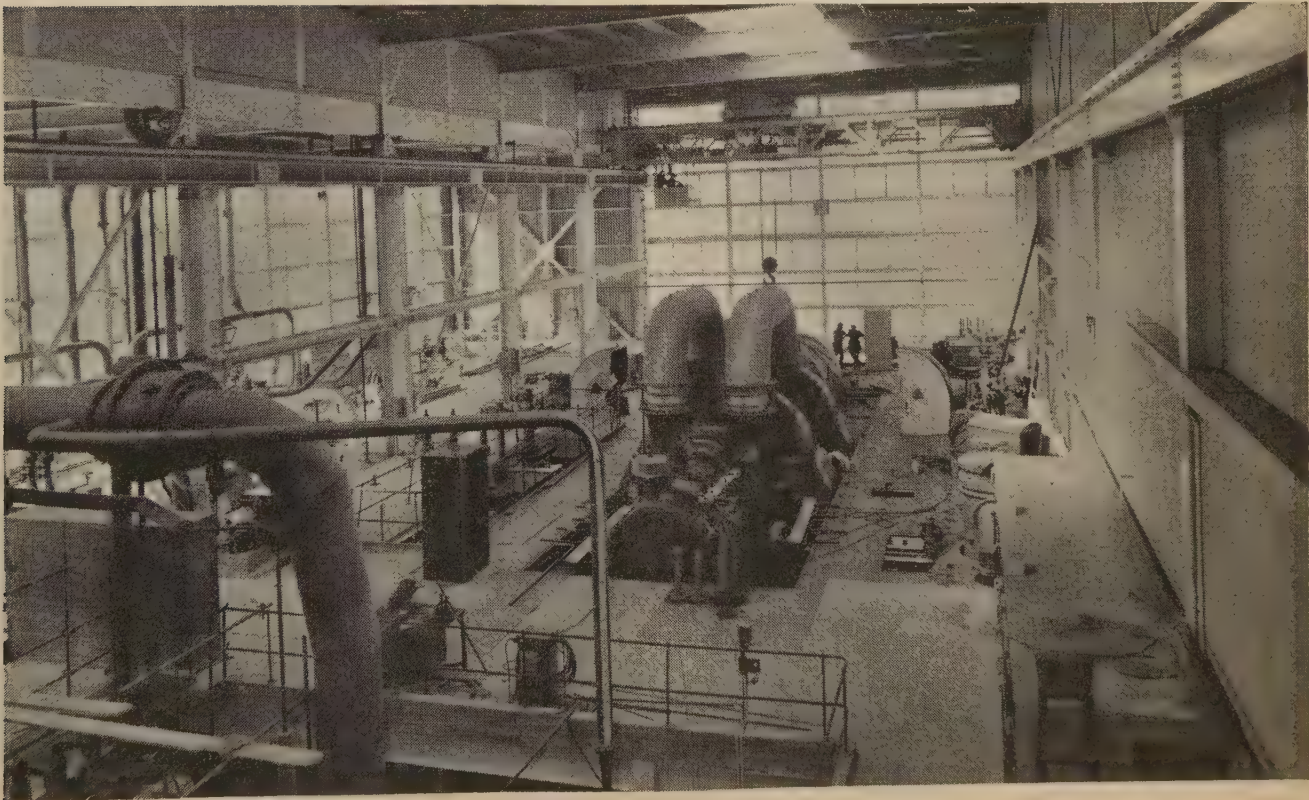


Fig. 9.—Heat balance diagram showing also the steam and water circuit in the heat exchanger

General view of the turbine hall showing the 33 MW machine nearing completion





Can failure detection room

tive to bled steam heating, to suit the special requirements of the reactor heat exchange system. The condensing plant is of standard twin-shell design, the circulating water temperature being 68°F at 24,500 g.p.m. The total surface area of the condenser is 31,800 sq ft.

As already mentioned, a 110 per cent duty dump condenser has also been provided for use when the turbine is out of commission, and this is also used when the reactor and heat exchangers are being started up. The condenser is designed to accept the full generated quantity of 310,000 lb/hr of steam at 650 p.s.i. and 850°F together with an extra quantity of 20,000 lb/hr of relief-valve steam from the standby steam-driven boiler feed pumps. The steam pipes serving the dump condenser are connected into a common steam receiver in parallel with the steam pipes serving the main turbine. Before admission to the dump condenser, steam pressure is reduced through four automatic control valves operating in conjunction with fixed aperture supersonic expansion nozzles. The steam is further expanded thereafter and reduced in velocity through taper ducts fitted with desuperheaters. Condensation takes place within the dump condenser at atmospheric pressure and the condensate is discharged into the main turbine feed system by two 100 per cent duty extraction pumps.

The four induced draught cooling towers are capable of reducing the temperature of 1.75 million gal/hr of condenser cooling water from 87 to 72°F. Air is induced through the laminated wood packing by four 26ft diameter, 851,000 cu ft/min wooden impellers driven by 140 h.p., 1,460 r.p.m. motors.

Electrical Connections

The main 33 MW generator is directly connected to the 11.5 kV, 500 MVA indoor switchgear which is in two sections with a normally closed bus-section switch. Each section is also connected by a 132/11.5 kV, 30 MVA transformer to the main 132 kV switchyard by an overhead line. There are seven 132 kV feeds into this substation, four from Calder Hall, one from Carlisle, one from Harker

substation, and one from Barrow. The 132 kV air-blast switchgear is rated at 2,500 MVA.

The 11 kV oil-break switchboard is connected to two 3.3 kV/air-break switchboards. There is a standby inter-connection between these two 3.3 kV boards, each of which is in two sections, with a normally closed bus-section switch. An 11.5/3.3 kV, 6 MVA transformer connects each section of each board to the 11 kV switchgear and each of these sections supplies one of the four 3.3 kV heat exchanger gas circulators. These 3.3 kV boards also supply the feed pumps and the circulating water pumps. The 3.3 kV system is resistor earthed and the connections into the containment building are phase-segregated. A ceramic seal has been provided where these connections pass through the steel containment building. The 415 V distribution supplies are taken from the 3.3 kV boards.

Bus-zone protection is provided on the 11 kV board and a Merz-Price system has been installed across the gas circulator main motors comprising three current transformers on the gas side within the pressure bell and three current transformers in the associated circuit-breaker.

Control and Operation

The rate of heat production in a nuclear reactor is the product of the coolant mass flow rate and the difference between inlet and outlet coolant temperature. In a civil power producing reactor, it is important to keep the coolant outlet temperature as high as possible. This is, of course, the main reason why the advanced gas-cooled reactor is being developed, i.e. to obtain higher fuel temperatures than the magnox reactors.

In the Windscale A.G.R., the inlet and outlet reactor coolant temperatures will be held constant and the power level will be proportional only to the mass flow rate of the CO₂ cooling gas. To change the power level of the reactor, the mass flow is controlled by altering the angle of the inlet guide vanes to the gas circulators. This in turn changes the fuel temperature which is then returned to its initial value by alteration in the control rod position. The inlet gas temperature is controlled by adjusting the feed water temperature to the economisers, by mixing hot and cold feed water and controlling the quantity of



Reactor control room

this mixed feed. The input signals to the feed water control system are obtained from drum level, steam flow, and heat exchanger outlet gas temperature sensing devices.

There are 18 manually-operated coarse control rods of boron steel and three manual/automatic fine control rods of stainless steel in the reactor. The automatic control of the fine rods is initiated by outlet gas temperature. The total reactivity controlled by the coarse rods is about 8 per cent, while each of the fine rods controls about $\frac{1}{4}$ per cent reactivity. Emergency shutdown devices have been provided on eight channels consisting of 1.4 per cent boron stainless iron balls which will absorb about 3.4 per cent reactivity. The balls are held above a fuel channel by a retaining magnet similar to the stator of a six-pole motor. In common with other sections of the reactor control system, the emergency shutdown devices operate on a two-out-of-three safety system. When two out of three of the pairs of poles are de-energised, the balls will drop into the reactor. The balls are arranged to fall into a special stringer which is removed complete to recharge these devices.

The main control rods, which weigh approximately 300 lb, are raised and lowered through a height of 16ft. They are suspended by stainless steel chains which are wound over a sprocket in the lower part of the mechanisms. The sprocket is driven through spur and bevel gearing by a permanent magnet synchronous motor which controls the position of the rod when supplied with variable low-frequency/zero frequency three-phase a.c. obtained via motor-driven sine potentiometers, with power amplification by rotary machines. The position of the rod is indicated at a central control desk by means of an electrical transmission obtained from a synchro which is geared to the sprocket drive. The maximum rate of insertion and withdrawal of the rods under normal operating conditions is 0.006in/sec and there is also a fast insertion speed of 0.060in/sec.

Under emergency conditions, it is necessary to insert the rods into the reactor core rapidly, and this is achieved by allowing the rods to fall under gravity, the speed of descent being controlled by regenerative braking of the motor. The two sections of the mechanism below the motor contain braking resistors, made of nickel/chrome wire wound on cylindrical ceramic formers, and cam-operated switches. The cam-operated switches, which are geared to the sprocket drive, connect the resistors into circuit at predetermined points in the travel of the rod to provide the required velocity/time characteristics of the rod under free fall conditions. The required conditions for emergency drop (seven seconds total time) are that the rod should fall under gravity through the first 7ft in approximately 3 sec and brake subsequently to reach a terminal velocity which does not exceed 1ft/sec. By means of air cooling at the outside of the refuelling branch, the temperature in the region of the rod motors is maintained below 150°C. The mechanism has an overall length of approximately 7ft.

Rather than using a complicated system of frequency control, the fine rods are operated by a high-speed a.c. servo-motor. Under automatic control, each of the chosen channel outlet gas temperatures is compared with demanded temperature and any difference signal is amplified and used to drive the control rods through transistor amplifiers feeding the two-phase induction motor in the

control rod mechanism. The maximum rate of movement of the fine rods is 0.36in/sec. A dead band is provided to prevent the control trying to follow noise in the temperature signals.

The fine control rods have been incorporated in the reactor to minimise temperature cycling of the fuel which occurs when large high-reactivity rods are moved. The fine rods have automatic control as it was thought in the

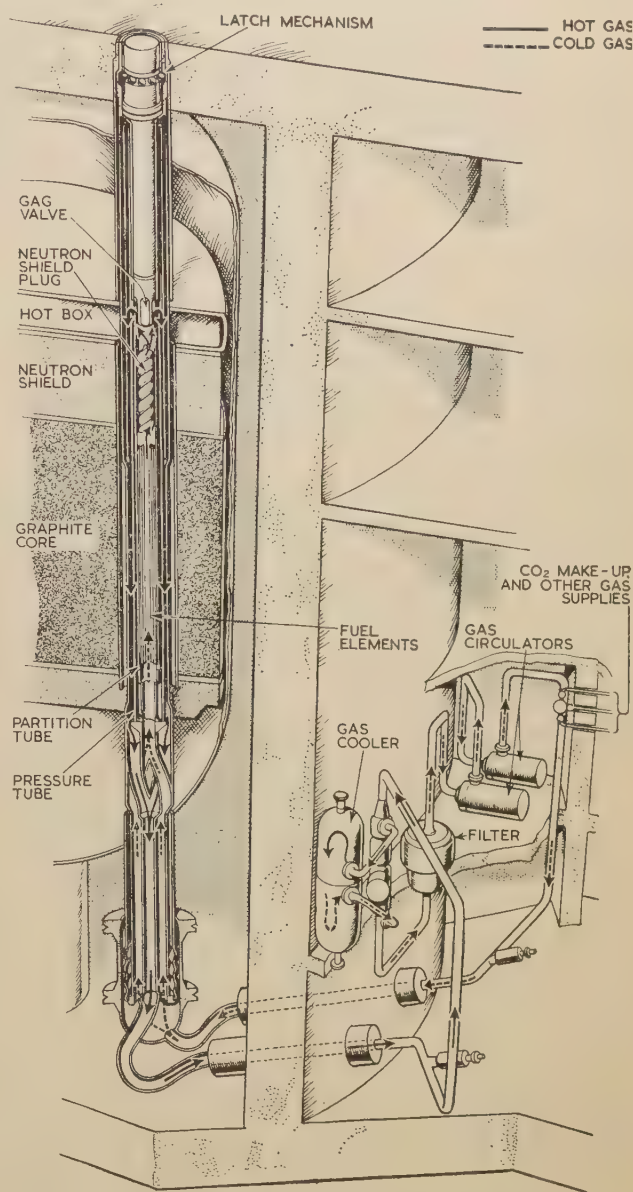


Fig. 10.—Perspective drawing of the experimental channels and their ancillary equipment

early stages of design that control with beryllium cans would be rather tedious, and also to obtain experience with sector control of instability zones.

The reactor control room contains, apart from all reactor controls and alarms, the dump condenser control system to ensure that reactor heat can always be removed. Turbine control is, of course, in the main electrical control room and the electrical output of the generator is depen-

dent on reactor output not, as would normally be the case, on electricity demand.

Instrumentation

Reactor power is measured by the quantity of neutron flux detected by ion chambers. This is, however, not entirely accurate as it varies with the control rod position. A thermal power indicator measures the difference between inlet and outlet gas temperature and multiplies by the mass flow through the core. These readings can be checked from the steam side when stable conditions occur. A data logger has been supplied and is situated in the reactor control room. It is a 450-point machine which is made to cover up to 1,200 thermocouples by switching out various non-essential banks in a predetermined order. The equipment includes 450 alarms which are brought out when the items under surveillance exceed the set points.

There is a 16 by 16 matrix system of burst slug detection (B.S.D.) incorporated in the reactor. Continuous monitoring of the matrix gives an immediate alarm if a burst occurs. Eight B.S.D. precipitators are housed in a single container so that only one mechanism is required to operate the wires for all eight units. With the matrix system employed, only four such eight-channel units are required to deal with the complete reactor.

Test Loops

The four experimental loops will be used to test fuel elements under more varied and advanced conditions than are available in the reactor. They are completely sealed

from the main coolant circuit to allow different coolant gases to be used (Fig. 10). Although they have their own cooling plant, and instrumentation, they are, however, serviced by the main refuelling machine. Two loop channels will take the normal Windscale A.G.R. elements, while the remaining two are rather smaller so that a higher flux can be obtained inside the loop. This higher flux is due to the reduction of the amount of absorbing material since, to withstand the gas pressure, the thickness of the smaller diameter tube can be reduced. Two further specially large channels are to be used for testing civil A.G.R. fuel elements.

Ventilation

The containment building is air conditioned in the working spaces and a separate cooling system is installed for rejection of the heat liberated within the structural materials of the inner containment. The air is finally discharged through scrubbing towers to the stack. A gas discharge treatment plant has been provided in case of accident and for use during blowdown operations.

Other facilities at Windscale in connection with the A.G.R. are fuel element examination laboratories, and the HERO zero energy research reactor.

Acknowledgments

A list of main contractors is given below. Acknowledgments are due to the Reactor Group of the United Kingdom Atomic Energy Authority for invaluable assistance in the preparation of the text.—T. C. J. Cogle.

LIST OF MAIN CONTRACTORS

Containment Building

Main foundations
and biological shield
Steel containment building
Structural steelwork

Heating and ventilating
Ventilation chemical plant

Whatlings, Ltd.
Babcock & Wilcox, Ltd.
Fleming Bros. (Structural Engineers), Ltd.
Matthew Hall & Co., Ltd.
Newton, Chambers & Co., Ltd.

Reactor

Pressure vessel
Graphite
Control rods
Control rod mechanisms and emergency shutdown equipment
Reactor instrumentation, cabling and panels
Burst slug detection
Data logger
Heat exchangers
Gas circulators
Gas circulator motors

Whessoe, Ltd.
Acheson Colloids, Ltd.
Hadfields, Ltd.
Elliott Brothers (London), Ltd.
Costain-John Brown, Ltd.
Plessey Co., Ltd.
English Electric Co., Ltd.
International Combustion, Ltd.
James Howden & Co., Ltd.
Laurence, Scott & Electromotors, Ltd.

CO₂ steam and feed water pipework
Main gas valves
Gas safety valves
Steam and feed water valves
Main reactor crane

Stewarts & Lloyds, Ltd.
J. Blakeborough & Sons, Ltd.
Cockburns, Ltd.
Hopkinsons, Ltd.
Wharton Crane & Hoist Co., Ltd.

Refuelling Machine

Main contractor

John Brown & Co., Ltd. (Special Engineering and Nuclear Division).
Colvern, Ltd.

Sensing head

Carousel

Main contractor

International Combustion, Ltd.

Turbine Hall

Civil engineering
Turbo-generator and feed heating plant
Dump condenser
Feedwater pumps
Overhead crane
Diesel standby sets
Frequency converter sets
Motor-generator sets
132/11.5 kV 30 MVA transformers
11.5/3.3 kV 6 MVA transformers
1,000 kVA transformers
750 kVA transformers
132 kV switchgear

Whatlings, Ltd.

English Electric Co., Ltd.
Hick, Hargreaves & Co., Ltd.
Mather & Platt, Ltd.
John Smith (Keighley), Ltd.
W. H. Allen, Sons & Co., Ltd.
Elliott Brothers (London), Ltd.
General Electric Co., Ltd.

C. A. Parsons & Co., Ltd.
Brush Electrical Engineering Co., Ltd.
London Transformer Products, Ltd.
Ferranti, Ltd.
Associated Electrical Industries, Ltd.
A. Reyrolle & Co., Ltd.
English Electric Co., Ltd.
Switchgear & Cowans, Ltd.
Whipp & Bourne, Ltd.
Pirelli-General Cable Works, Ltd.

11.5 kV switchgear
3.3 kV switchgear
415 V switchgear
Main d.c. switchgear
High voltage cabling

General Electrical Installation

Main contractor

N. G. Bailey & Co., Ltd.

Cooling Towers

Main contractor

Davenport Engineering Co., Ltd.

Some Aspects of the Nuclear Power Programme

By C. W. A. PRIEST, B.Sc.(Eng.), A.M.I.Mech.E., M.I.E.E.*

The £350 million investment in the first six civil nuclear power stations is intended not merely as part of a development programme for nuclear power: it is a serious part of the whole generating construction programme in the U.K. However, one of the major planning problems is when to make the change from magnox to advanced reactor systems

WHEN the nuclear programme was envisaged in the mid-1950's the outlook for the supply of home-produced coal for electricity generation was not encouraging. It was thought that coal supplies would be equalled by demand within ten years or so, and thereafter be in deficit. Oil imported to home refineries was, however, making available large quantities of residual oils of high viscosity but, with the political atmosphere after the Suez trouble, these supplies were regarded as unreliable. The possibility of importing coal in very large quantities was negated by the state of the national economy.

Nuclear power had arrived at a propitious moment. The initial cost comparisons, made against the costs of coal-fired stations at the time, were not too unfavourable and nuclear power gave promise of breaking even in an acceptably short time by power station development standards. Also, natural uranium was being located in Canada and within the sterling currency area. To avoid the necessity of purchasing uranium 235, or heavy water on a relatively large scale of hard currency, or of extending the separation plants, the British proposals concentrated on reactors using refined natural uranium fuel with graphite as the moderator and carbon-dioxide as the coolant.

The then Government accepted the nuclear programme arising from the 1954 White Paper and the Central Electricity Authority and their successors, the Central Electricity Generating Board, have placed orders for six nuclear stations at Bradwell, Berkeley, Hinkley Point, Trawsfynydd, Dungeness and Sizewell. Tenders for a seventh, at Oldbury, are now being examined, while application for permission to build an eighth at Wylfa in Anglesey is awaiting the decision of the Minister of Power. There is a continuing commitment for the Generating Board to commence building one additional nuclear station each year (see diagram).

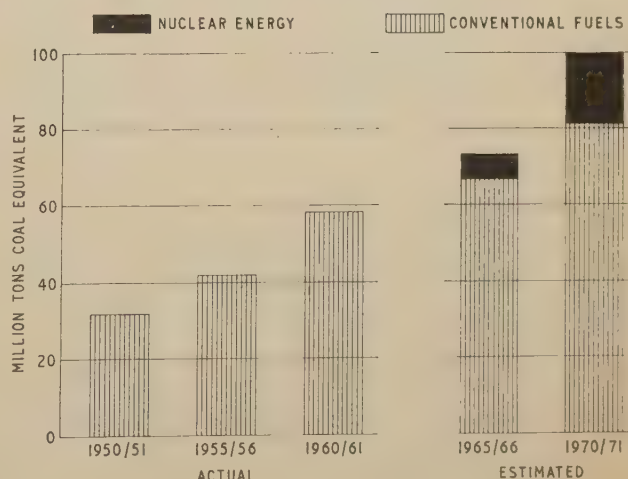
The first six stations in aggregate have a "sent out" generating capacity of 2,704 MW and are expected to cost nearly £350 million. Oldbury will probably be rated at around 550 MW sent out and will cost approximately £100/kW. The Wylfa application has been based on an

output of up to 800 MW, probably at a still lower cost if based on today's prices.

All this investment and all this capacity are obviously not intended as a development programme. It is the counterpart of the expenditure by the Board on the new so-called conventional power stations which will burn home-produced coal and some oil to meet the continuously rising demand for electricity. Of course, it is true that the later nuclear stations will contain many changes in major component design compared with the Bradwell-Berkeley arrangements, but this changing pattern must be true of any type of engineering. The initial cost of a complete station has come down from an expected £160-£165/kW sent out at the two original stations to around £100/kW sent out in the later stations. Most of this reduction might be credited to the size change from 137.5 MW per reactor at Berkeley to 275 MW per reactor at Sizewell and possibly to 400 MW per reactor at Wylfa. Another appreciable factor in cost reduction has been the reflection in nuclear stations of the immense development in turbine plant design for conventional stations, arising from the greater knowledge and experience available to the designers.

Unfortunately, the earlier stations suffered quite

Fuel consumption of the electricity supply industry (England and Wales)



* Chief Design and Construction Engineer, Central Electricity Generating Board.

important cost penalties when new information on graphite necessitated core re-design part-way through the production stage. Also, fuel-can design and production has been a time- and money-consuming process.

In the final result, therefore, a vast amount of fundamental and development information is now available on the magnox type of reactor to the U.K.A.E.A., the C.E.G.B. and to the consortia, which must lead to more positive and "tailored" designs in the future, with the incentive of still further paring initial and operating costs.

It is pertinent to recall that when the Bradwell-Berkeley proposals were being formulated the only large reactor experience was derived from operations at Calder Hall. These 40 MW reactors had been installed as plutonium producers, providing electricity as a by-product and arranged for off-load fuel changing, whereas commercial generation demanded electricity as the main product, on-load fuel changing and leaving plutonium as a by-product.

Exhaust Wetness

The table shows how the various groups have tackled the task of reducing cost and improving efficiency at the turbine end of a nuclear station within the limits imposed by the common concept of a magnox station having the same pattern of natural uranium fuel, magnox can, graphite moderator and carbon-dioxide coolant. The table lists some of the leading details, commencing with six 52 MW machines at Bradwell and passing in slightly uneven steps to just two 325 MW units at Sizewell. Note also the percentage wetness at the exhaust end of the machines. As a general yardstick in the design of conventional stations, the wetness of the exhaust would be acceptable at 10 to 11 per cent on a 3,000 r.p.m. turbine rising to 14 per cent at 1,500 r.p.m. Beyond that it would be expected that the erosion of the last few rows of blades would be unacceptable even with special leading edge shields. At Trawsfynydd, the calculated wetness with the designed steam conditions worked out at 17.2 per cent at 3,000 r.p.m. so that special separators have been designed to be installed at the cross-over to the l.p. multiple cylinders. Separators have also been deemed necessary at Dungeness to bring the figure down to 14.2 per cent on the 1,500 r.p.m. turbines. At Sizewell, reheaters are to be employed to produce 7.9 per cent wetness at exhaust, whilst the speed is retained at 3,000 r.p.m.

Economic Factors

The economics of nuclear power stations are by no means simple in themselves and become quite difficult when compared with those of conventional stations. Ordinary natural uranium must eventually come down in price due to the large deposits of uranium-bearing ore which have been discovered throughout the world—much in excess of the present foreseeable demand. The buy-back price of irradiated or spent elements from the power stations may also fall significantly because of the lack of

STEAM CIRCUIT DETAILS OF BRITISH CIVIL NUCLEAR POWER STATIONS

		Bradwell	Berkeley	Hinkley Point	Trawsfynydd	Dungeness	Sizewell
No. of Turbines ...		6	4	6	4	4	2
Output per Turbine	MW	52	80	93.5	145	142.5	325
Speed of Turbine ...	rpm	3,000	3,000	3,000	3,000	HP3,000 LPI,500	3,000
H.P. Pressure ...	psig	730	310	615	925	1,395	646
H.P. Temperature ...	°F	700	605	680	716	735	728
L.P. Pressure ...	psig	180	64	155	290	535	253
L.P. Temperature ...	°F	700	596	655	690	735	728
Feed Temperature ...	°F	190	173	169	220	356	250
Vacuum ...	in Hg	28.9	29.1	29.0	28.8	28.9	29.0
Steam wetness at exhaust ...	%	14.8	11.8	12.7	11.0	14.2	7.9
Wetness Control ...	—	—	—	—	L.P. Separator	L.P. Separator	Reheat

commercial reactors utilising plutonium, whilst perhaps the most important item is as yet unchecked, namely, the actual megawatt-days achieved per tonne of fuel fed to the reactor. If this be greater or less than the usually accepted figure of 3,000 MWd/Te, then fuel costs will reflect the changes in direct proportion.

In the conventional field, a very significant change has been effected and the cost of the 2,000 MW stations now under construction is expected to be around £35/kW sent out and quite possibly a little lower. Efficiencies will also improve, since the accepted steam pressure of 2,350 p.s.i.g. at the turbine stop valve is accompanied by an initial steam temperature of 1,050°F with a single reheat to a like figure. Exceptionally, the Generating Board has also ordered two supercritical units for Drakelow "C," each of 375 MW capacity and operating at 3,500 p.s.i.g., 1,100°F at the turbine stop valve plus one reheat to 1,050°F. These units will cost slightly more than the normal 2,350 p.s.i.g. range, but the higher efficiency obtainable should equate the overall generating costs. When the first nuclear programme was published, the initial price of generating plant then being ordered was around £50-£55/kW and developments in coal-fired plant have, therefore, retarded the break-even date for nuclear stations. Conventional plant has not reached its limits although, obviously, further improvements must be relatively more difficult.

Nevertheless, all estimates seem to agree that in another ten years or so there will not be sufficient coal to meet electricity demands and the increasing gap can only, with present knowledge, be filled from nuclear energy sources. The first phase, of magnox stations, must inevitably be reaching its end, hopefully pointing to the third phase "breeder" reactors, as yet in the future. The point must surely be "how soon" will the breeder become a practical commercial proposition, for only if the third phase is still away in the mists is it reasonable to suggest that a second phase is commercially desirable.

Advanced Reactors

If a second phase string of stations is judged to be the correct approach, then the advanced gas-cooled reactor must immediately become a serious competitor for approval. It will allow of the use of higher steam temperatures and pressures to enable the turbine end more nearly to approach the advanced designs and efficiencies

possible in the conventional field, assuming that the reactor problems associated with higher temperatures can be overcome. The Windscale A.G.R. prototype has already received much attention—and will continue to receive much attention—from the engineers of the Generating Board and of the consortia. Yet there are some other reactors of the second phase class being developed which must also receive careful consideration, as also must the other major problem of when to make the change from magnox.

Engineering has many examples of the dangers of “design by extrapolation” and the high cost of the stations at Bradwell and Berkeley from the limited experience of the Calder Hall units reflects this point.

Civil Nuclear Power Stations

THE main parameters of the British civil nuclear power stations now under construction are given in Table 1 and these can be compared with those for Calder Hall and the Windscale A.G.R. The maximum fuel ratings at Calder Hall are 3 MW/te, 4.5 MW/te at the magnox civil stations and 19.5 MW/te in the A.G.R. The Italian and Japanese stations being built by British firms are also included in the Table. Table 2 gives details of some foreign electricity-producing nuclear reactor plants.

A comparison of some estimated costs of electricity generation by typical British nuclear, coal and hydro-electric power stations is given in Table 3. The capital costs per kWh include redemption fund charges as well as interest on the capital. In the case of the nuclear stations, the capital costs exclude the initial fuel charge. Comments on these costs appear on our leader page.

Very serious thought must be given to directing the decision for or against a second stage station to a point in time when sufficient information is available to restrict, as much as is feasible, the cost of development during construction. Such information may spring directly from research, to rethinking during prototype development or from sheer experience in operation and, if the last, the main decision must necessarily be delayed.

But, whatever the outcome and whenever the magnox station concept is superseded, the construction of the immensely interesting A.G.R. prototype at Windscale must mark a large step forward in nuclear experience and knowledge. Every credit is due to the team which produced it.

TABLE 1

	No. of Reactors	Net Output/Reactor MW(E)	Date Commissioned	Coolant Outlet (°C)	Coolant Pressure (p.s.i.)	Efficiency (%)
U.K.A.E.A. Calder Hall "A" & "B"	4	45	56	333	100	20
C.E.G.B.						
Bradwell	2	150	61	390	147	28.2
Berkeley	2	138	61	345	140	24.4
Hunterston	2	150	63	402	165	28.0
Hinkley Point	2	250	63	375	200	26.4
Trawsfynydd	2	250	63	399	255	28.7
Dungeness	2	275	64	410	283	32.9
Sizewell	2	290	65	410	279	30.5
U.K.A.E.A. Windscale A.G.R. ...	1	28	62	575	270	28
British Manufacture Latina (Italy)	1	200	64	390	197	28.4
Tokai-Mura (Japan) ...	1	158	65	280	220	27.7

TABLE 2

	No. of Reactors	Output/Reactor MW(E)	Date Commissioned	Type
CANADA Douglas Point (CANDU)	1	200	64	Heavy Water
FRANCE				
EDF-2	1	170	63	G/CO ₂
EDF-3	1	375	65	G/CO ₂
U.S.A.				
Shippingport	1	60	57	Light Water
Dresden	1	184	59	Light Water
Yankee	1	110	60	Light Water
Indian Point	1	255	61	Light Water
U.S.S.R.				
Siberian	6	100	58	G/H ₂ O
Kurchatov (Beloyarsk)	4	100	61	G/H ₂ O
Voronezh	2	210	61	Light Water

TABLE 3

Type of Station	Economic Life Years	Load Factor %	Capital Cost £/kW (installed)	Capital Cost d/kWh (at 5½% int.)	Fuel and Operating Costs d/kWh	Total Costs d/kWh
Modern Coal Fired ...	30	75	40	0.1	0.45	0.55
Hydro-Electric ...	40	30 (75)	140	0.80(0.34)	0.05	0.85(0.39)
Magnox Nuclear ...	20	75	160/100	0.49/0.30	0.30	0.79/0.60
A.G.R. ...	20	75	100/60	0.30/0.18	0.27	0.57/0.45

INDUSTRIAL ILLUSTRATION

The detailed illustration of the advanced gas-cooled reactor included in this issue was prepared by Mr. Max Millar, senior editorial artist of Associated Iliffe Press, Ltd. His previous work for the *Electrical Review* has included similar drawings of the Ffestiniog pumping station, High Marnham power station and Hunterston and Calder Hall nuclear generating stations. Recently he completed a book entitled

“Know How to Draw” and in this he explains, simply but fully, perspective, the drawing of ellipses, composition and arrangement, light and shade, and the preparation of three-dimensional illustrations from working drawings. This book will be of considerable value to those in industry who require to illustrate their ideas. It is published, price 12s 6d, by B. T. Batsford, Ltd., 4, Fitzhardinge Street, W.1

The Magnetic Containment of Plasma

By P. A. DAVENPORT, M.A., D.Phil.*

Complex magnetic field configurations are required for the stable containment of hot plasma, a crucial factor in plasma physics research. The author explains the current lines of development in this field and gives an indication of future possibilities

THE release of energy which accompanies the fusing together of the nuclei of light elements is the source of the enormous power radiated by normal stars, of which the sun is a typical example. Nearly all terrestrial sources derive power from the storage of solar radiation which, in the case of fossil fuels, has taken place over geological spans of time. It is natural to inquire whether these processes can be short circuited and if the controlled release of fusion energy can be used directly as an economic power source. The potential advantages of a fusion reactor—the abundance of fuel and the relative freedom from toxic and explosive hazard—are so attractive that most technologically advanced countries have embarked upon research programmes exploring the feasibility of controlled fusion power.

The method of achieving controlled fusion which appears to offer the best chance of success is to heat a thermally isolated mixture of the heavier isotopes of hydrogen—deuterium and tritium—to a temperature at which the thermal velocities of the nuclei are great enough to overcome the electrostatic repulsion between their charges, thus making the fusion of the nuclei sufficiently probable to provide a useful power yield. From measurements of the reaction cross-sections it can be calculated that temperatures of the order of 100 million degrees are necessary.

Matter at such elevated temperatures exists in a fully ionised state known as plasma. Although the bulk of the matter in the universe exists in the plasma state, and terrestrial plasmas such as flames and electrical discharges in gases are commonplace, little is yet known of the detailed properties and behaviour of plasma, particularly from the dynamical aspect. Thus the main present trend in the field of controlled fusion is towards basic research in plasma physics.

In order to study the properties of hot plasma, it is necessary first to produce a pure cool plasma and then to heat it in virtually complete isolation from material surroundings. The reason for purity is that, particularly in the case of hydrogenic plasma, with which fusion research is mainly concerned, impurity atoms, partially stripped of their electrons, are very efficient radiators of energy in the form of line radiation, and the power input intended to heat the plasma can be almost wholly dissipated in this way. The reasons for isolation are two-fold: not only does the loss of hot plasma from an experimental system represent a power drain, but its arrival at the material walls of the system releases atoms which find

their way into the main body of the plasma, rendering it impure.

Plasma has two obvious properties; it has mass and, being highly ionised, is a good electrical conductor. Hence three methods of confining plasma in thermal isolation suggest themselves, the use of gravitational, electric and magnetic fields. Gravitational fields are relatively weak and are effective only for plasma of stellar dimensions. The pressures which can be exerted by electric and magnetic fields are limited by the energy

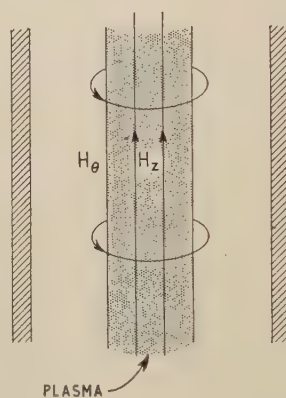


Fig. 1.—Stabilised pinch configuration

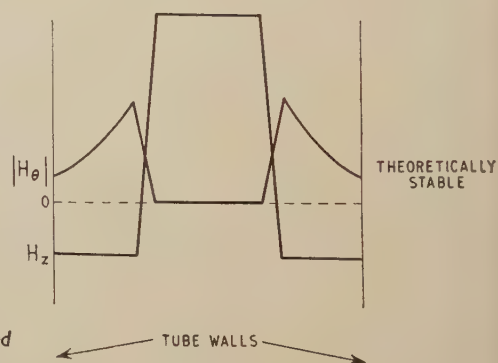
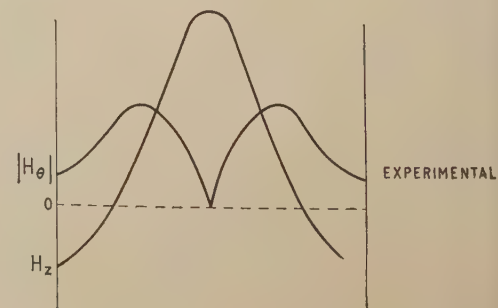


Fig. 2.—Stabilised pinch fields



* Culham Laboratory, United Kingdom Atomic Energy Authority.

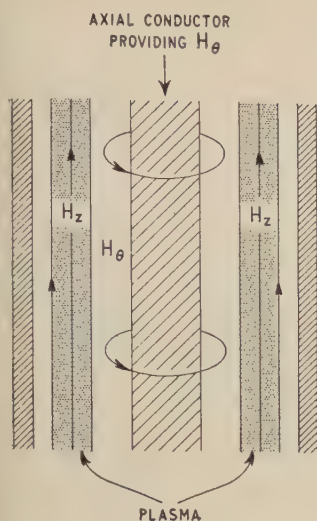


Fig. 3.—Hard core geometry

densities of the fields. Comparison with the pressures required to contain thermo-nuclear plasmas leads to impossibly high electric fields, of the order of 10 million volts per centimetre, and electric containment can be ruled out on these grounds alone. Comparable magnetic pressures, however, can be obtained with fields of 30 kilogauss, which can be produced in the laboratory without difficulty. For these reasons all attempts to solve the problem of plasma containment rely on the use of magnetic fields.

The problem of plasma containment is to find a configuration of magnetic fields which confines the plasma stably for periods sufficiently long to allow useful experiments to be done and, ultimately, for long enough to allow a useful fraction of a reacting plasma to undergo fusion. The need for stability is crucial, because the large electromagnetic forces involved and the small inertia of the plasma cause instabilities to grow very rapidly, which greatly hampers experiments on plasma properties.

The design of containment geometries is guided by theoretical considerations of stability, based on the so-called hydromagnetic approximation, which regards the plasma as an electrically conducting compressible fluid and ignores the microstructure of an actual plasma, which consists of energetic particles of differing charge and mass, gyrating in local magnetic fields. This microstructure leads to interactions, individual and co-operative, which cause instabilities and impair containment. A simple example is the slow scattering of particles out of the containment system, due to their mutual collisions. A more complicated and serious example is the occurrence of runaway electrons, which arise when the energy gained by an electron from an electric field in a mean free path becomes comparable with its thermal energy. Since Coulomb cross-sections decrease with increasing energy, such electrons may gain energy indefinitely once started. Beams of fast electrons can generate plasma oscillations, and these in turn may give rise to increased diffusion across magnetic fields, impairing containment. Several more complicated interactions leading to instability have been studied both theoretically and experimentally, but so far no fundamental obstacle to the magnetic containment of plasma for times adequate for fusion research has been revealed.

Several types of confining fields are being currently exploited in plasma physics experiments. The principal

ones fall into five categories, the stabilised pinch, hard core geometry, stellarator geometry, mirror geometry and cusp geometry.

The well-known stabilised pinch configuration (Fig. 1) has been the subject of extensive theoretical and experimental study, in both cylindrical and toroidal geometry. An attractive feature is that the confining field is derived from currents flowing in the plasma itself; these currents will simultaneously heat the plasma. The fields so far obtained in experiment are only a rough approximation (Fig. 2) to those theoretically required, and instabilities and plasma losses are observed. The object of much current work is to establish that these instabilities are of the type predicted theoretically.

The hard core geometry (Fig. 3) is so named because it requires a rigid axial conductor. In theory it is hydromagnetically stable over a wider range of parameters than the stabilised pinch. Experiments are being carried out to compare stability in cylindrical tubes with and without the hard core, with the aim of separating the effects of hydromagnetic instabilities from others, for example, from those due to runaway electrons. However, detailed interpretation of results has proved unexpectedly difficult, perhaps because of electrode effects in the cylindrical geometry used. Experiments are planned in toroidal geometry, but these involve practical complications such as the necessity for levitating the hard core by mechanical or electromagnetic means.

Stellarator geometry (Fig. 4) is toroidal but differs essentially from the stabilised pinch configuration in that the confining field is entirely produced by external currents flowing in solenoidal windings encircling the plasma, not by currents flowing in the plasma itself. The confining field is said to possess a rotational transform, by which it is meant that a magnetic line of force, followed indefinitely round the system, generates not a closed loop but an entire toroidal surface. This is achieved either by distorting the torus into a figure-of-eight shape, or by adding a coarse-pitch helical winding to the solenoidal winding producing the confining field. The object of the rotational transform is to cancel the vertical particle drifts which occur when the confining field possesses a gradient, as it must do in the curved sections. If the rotational transform is produced by helical windings the confining field has the additional property that the pitch of the lines of force changes with distance from the axis. This is thought to inhibit a type of hydromagnetic instability which occurs when magnetic lines of force can interchange positions with negligible bending.

Mirror geometry (Fig. 5) employs a solenoidal field of cylindrical symmetry which increases in strength at each end of the configuration. Charged particles gyrating in

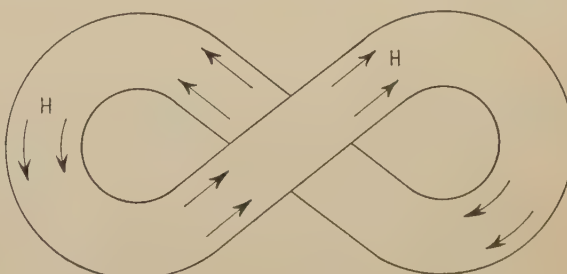


Fig. 4.—Figure-of-eight stellarator geometry

this shape of field suffer reflection from the regions of increasing field strength—the mirrors—provided the angle between their velocity vectors and the central field lines exceeds a critical value. This angle is given by

$$\sin \theta = \sqrt{\frac{H_0}{H_M}}, \text{ where } \frac{H_M}{H_0} \text{ is the mirror ratio, the ratio of}$$

maximum to central field strengths. (A resemblance to the condition in classical optics for total internal reflection will be noted.)

Consequently, there is a loss cone in velocity space from which particles will escape from the confining field. As this loss cone is continuously replenished by collision processes, there is a definite steady leak through the mirrors. Since the high field regions act as bottlenecks, the term magnetic bottle is often applied to mirror geometry.

Cusp geometry (Fig. 6) has an important feature which is absent from other configurations; the magnetic field increases with distance from the plasma surface. Theoretically, this is a sufficient condition for stability. As in the case of mirror geometry, the lines of force are not closed within the system, and hence some leakage of plasma through the apexes of the cusps is inevitable.

The containment systems so far described employ stationary or quasi-stationary magnetic fields. The use of magnetic fields oscillating at radio frequencies is also being studied. They have the advantages that the range of possible configurations is extended due to the presence of displacement currents and that the focusing action of rapidly oscillating fields may help to quell plasma instabilities. The use of fields at microwave frequencies has been suggested for suppressing the leaks inherent in magnetic bottles and in cusp configurations.

All the above plasma containment systems are made under laboratory conditions, but it has recently been realised that a natural containment system is available for experiments. The magnetic field of the earth forms a

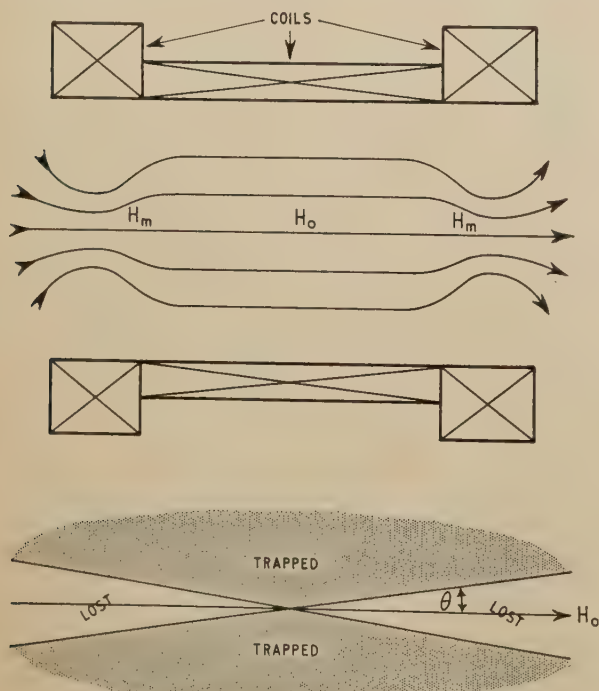


Fig. 5.—Mirror geometry and loss cones

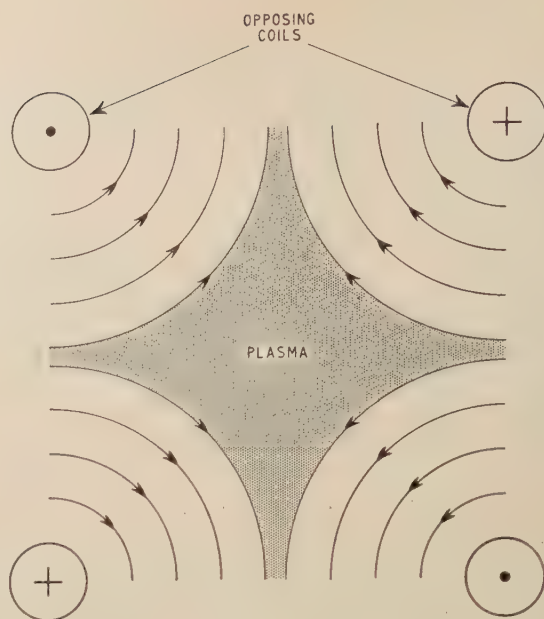
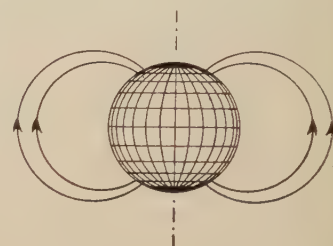


Fig. 6.—Cusp geometry

Fig. 7.—The earth's magnetic bottle



large permanent magnetic bottle (Fig. 7), and the van Allen belts consist of charged particles trapped there. The Argus experiment, in which charged particles were injected by rocket into this magnetic bottle and their subsequent diffusion and loss measured by satellite probes, is the largest-scale plasma containment experiment yet performed.

Magnetic containment systems, particularly those which for physical reasons need to be on a large scale, are a formidable challenge to electromagnetic technology, and many departures from normal power engineering practice will be necessary. Arising from research in this field, it may be expected that significant advances will be forthcoming in the techniques of economical energy storage, precise high-current switching and cryogenic magnetic coil design, to name but a few. These may have far-reaching influence in a widely differing variety of applications.

CHURCH LIGHTING AND WIRING

A revision of the booklet "The Lighting and Wiring of Churches" has been published for the Central Council for the Care of Churches by the Church Information Office, Church House, Dean's Yard, Westminster, London, S.W.1, price 2s 6d. The first part outlines the purposes of the lighting installation and discusses the types of fittings available. An appendix states the illumination levels required in various parts of a church. This is followed by a section on wiring, which covers the service cable to the church, metering, switchgear, wiring, flexible cords, switchboard sockets, connections to lighting fittings and heating appliances, and motors and organ apparatus.

INDUSTRY AND THE HOUSE

Debate on the Economic Situation

By AUSTEN ALBU, M.P., B.Sc., A.M.I.Mech.E., M.I.P.E.

THE new leader of the House, Mr. Iain Macleod, winding up the debate on the Queen's Speech, referred to the lack of interest that the debate had aroused in Members. He thought, rightly as it seems to your contributor, that the reason was that members were preoccupied with the great issues of world politics which were not susceptible to Bills passed in Parliament, but which would determine whether or not mankind was going to destroy itself. Unfortunately, his brief incursion into the higher realms of philosophic statesmanship came after a speech, witty enough in its opening to match that of Mr. Harold Wilson, which was for its major part more suited to Mr. Macleod's other position, that of chairman of the Conservative Party.

The last day of this debate was occupied with the economic situation and was opened by Mr. Gaitskell in a thoughtful, if depressing, speech. Criticising the Government's economic policy for being largely negative—high interest rates, credit squeeze, more indirect taxes and borrowing overseas—he said that none of these measures was directed to the long-term problems facing this country. Production had flattened off, steel production was at only 77 per cent of capacity, we had become a net importer of ships, and the Federation of British Industries reported signs of contraction of output and of order books.

Smaller Share of World Trade

Although there had been some rise in exports this year, the latest figures were lower than in any month this year except May and our share of world manufactures continued to fall. We needed specific measures for the long-term solution of our problems.

Mr. Gaitskell criticised the high rate of interest in this country, which was costing our balance of payments about £100 million a year. (The effect of this high rate on British exporters was the subject of a number of speakers in this debate and also in the debate on Friday last on the second reading of the Export Guarantees Bill.) Mr. Gaitskell referred specifically to things the Government should be doing to encourage exports, insisting that firms should be compelled to publish in their annual accounts the proportion of their output which was exported, that export business should be given credit preference, and that employment exchanges should give preference in the supply of skilled labour to those firms engaged in export. He also asked for the setting up of working parties for individual industries with a poor export record.

On the Government's planning proposals, he said that they were a complete mystery. He commended the French experience to the Government and pointed out that France had a number of important sanctions such as strict control of access to the capital market and accelerated depreciation allowances for firms exporting more than 20 per cent.

The Chancellor of the Exchequer referred to the dangers of acting contrary to our international obligations by, for instance, giving tax relief to exporters and asked

for instances of this being done in other countries or of cases of subsidising of credit rates. He rejected the suggestions that had been made for a turnover tax on the German model, with relief for exports. He said that we must continue with our present policies and continue to restrain home demand. The advice given him was that in the early part of the year there would be strong expansionary forces at work again. We had to curtail Government expenditure overseas. As a deficit country we could not afford to add to the existing imbalance by payment of large sums across the exchanges to West Germany, a surplus country, for the maintenance of our troops. This was the responsibility of N.A.T.O.

On his planning proposals, Mr. Lloyd said that he had in mind a body which did not meet just to comment on decisions already taken. One purpose was the examination of the problems involved in national economic development and of the forward plans for the different sectors of the economy, and for particular industries, and an examination of the obstacles to sound growth. He envisaged a council, not very large in size, which would recommend and perhaps make declarations. It would provide a great opportunity for both sides of industry to influence policy at the formative stage. The staff of the council must have a measure of autonomy but it must work within lines generally laid down by the council.

Mr. Harvey Rhodes, the woollen manufacturer, who is Labour Member for Ashton-under-Lyne, said that a return should be made to the central planning authority every two months of earnings in industry, every month of orders in hand, every three months of the stocks held and every three months of export performance. He would make individual industries responsible for their own figures and the assessing of their own productivity. A Conservative Member, Mr. John Harvey, said that it was not necessarily right for the Government to cut public expenditure all the time. Some examination of the needs of the nation as a whole was imperative. It might be necessary to spend more on the education services in order to give us people educated in the skills we would need in the years to come.

Suggested Remedies

Mr. B. Z. de Ferranti said that the immense purchasing power of the central Government, the nationalised industries and the local authorities, which amounted to 40 per cent of our gross national product, should be used in a more rational way to achieve a solution of our export problems and increase the rate of growth. The Government should also use schemes such as those employed in the aircraft and textile industries and anything else that appeared sensible, such as civil development contracts, in those industries technologically lagging behind the Americans, the Russians or the Europeans. He believed that members should stop arguing whether planning was a good thing, should drop the "isms," and

should now get on with arguing what the rate of growth could and should be. He was interested to learn in Paris that the French now regarded exports as a problem of the past because of the success of modernisation encouraged by the working groups.

Mr. Harold Wilson said that all German banker-industrialists agreed that the turnover tax, with its exemption for export, was the biggest single factor in their export drive. He said that the idea of an export-import bank and of favourable rates of interest for exporters had been dismissed by the Chancellor in the most perfunctory manner, true to the Treasury motto—"Never do anything for the first time."

Export Guarantees Increased

The Export Guarantees Bill was introduced by the new Minister of State at the Board of Trade, Sir Keith Joseph. It raises the limit of the amount which the Export Credit Guarantee Department may cover by way of credit insurance under Sections 2 and 3 of the present Act from £400 million to £800 million. These sections cover business which, though not considered a good commercial risk, is held by the Government to be in the national interest, and economic assistance loans to under-developed countries which are tied to projects in this country. Mr.

Douglas Jay, for the Opposition, asked for lower interest rates for export credits, as had been provided to some extent in the United States and France and he was supported by another Labour Member, Mr. Richard March. He thought there was need of a new source of credit for loans of over five years. Mr. Nicholas Ridley said he had heard it rumoured that some foreign Governments were offering honours for those who bought their exports! He said that sometimes the Department would cover only a rather low percentage of the credit required; credit should be available up to the maximum required, the premium for the insurance cover being increased if necessary. Sir John Vaughan Morgan, himself an ex-Minister of State, said the Department's work met with the approval of the overwhelming mass of the business community.

In replying to the debate, Sir Keith dealt with the question of the availability and rates of export finance. Rather surprisingly, in view of what one Chancellor of the Exchequer had said earlier in the week, he said that the Chancellor was determined to search for improved export terms in the form of both the availability and rate of finance. It was true that some countries had differential rates but this was an important factor in only a small range of exports.

Transformers from Canada

MR. S. Z. DE FERRANTI'S VIEWS

TWO weeks ago we commented upon the purchase by the Central Electricity Generating Board of two 90 kVA transformers from the Canadian General Electric Co. We have now received the following communication from Mr. Sebastian Z. de Ferranti, who is managing director of Ferranti, Ltd., and a director of Ferranti-Packard Electric, Ltd., Toronto:—

"The leading article in the *Electrical Review* of 3rd November calls for comment on two counts. It fails to point out that the present open-price system under which the transformer manufacturers operate in this country is highly competitive. Such a system, either inherent or arranged, is the normal means of pricing any commodity. It depends on price leadership, and the position of price leader is invariably occupied at any one time by the most efficient manufacturer.

"The second point which needs to be emphasised is that the present Canadian 'home' level is completely uneconomic and is producing losses for the Canadian transformer manufacturers. I have the same facilities for the production of large transformers in Canada as I have in this country, so I can say that the price which I understand is to be paid for these two transformers is well below the economic level. Further proof of the depressed price level is that precisely the same transformers made in America would be sold at a 25 per cent higher price. Furthermore, costs are higher in Canada than in America.

"From the national point of view the C.E.G.B.'s action is irresponsible in that they were, or should have been,

aware of the artificially low level of Canadian prices. Their action is presumably intended to depress British transformer prices, and if it succeeded in doing this, it would merely accelerate the tendency for this country to become a poor, and technically second-rate nation.

"The return before tax and before dividend on the total capital employed in three of the largest electrical businesses in this country is now between 5 and 7 per cent. This is disastrous, and the C.E.G.B. must take some responsibility for this ruinous state of affairs."



Mr. S. Z. de Ferranti

LAMP DIMENSIONS AND HEAT EFFECTS

THE first of three papers read at a meeting of the Illuminating Engineering Society on 14th November described "Changes in the Dimensions of Incandescent Filament Lamps." In this paper, Mr. A. G. Penny states that one of the technical achievements which made possible the more recent reductions in size was the development in 1954 of capping cements which would withstand temperatures of over 200°C. Some fittings in current production do not have such a large margin of safety, from the temperature point of view, with the smaller bulb lamps, and careful study of the lampholder, cable and fitting temperatures has become necessary. This study calls for certain new techniques which are described in the paper on "A Standard Heat Test Lamp for the Temperature Testing of Lighting Fittings" by J. N. Bowtell and J. R. Coaton, and in the third paper entitled "Temperatures and Temperature Variability in Lighting Fittings for Filament Lamps" by Joan Keen and H. F. Stephenson.



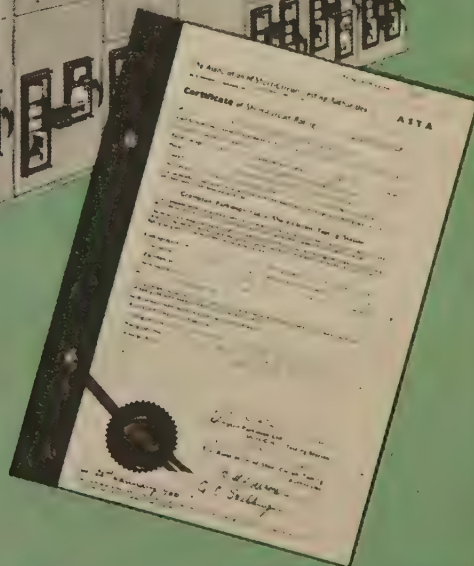
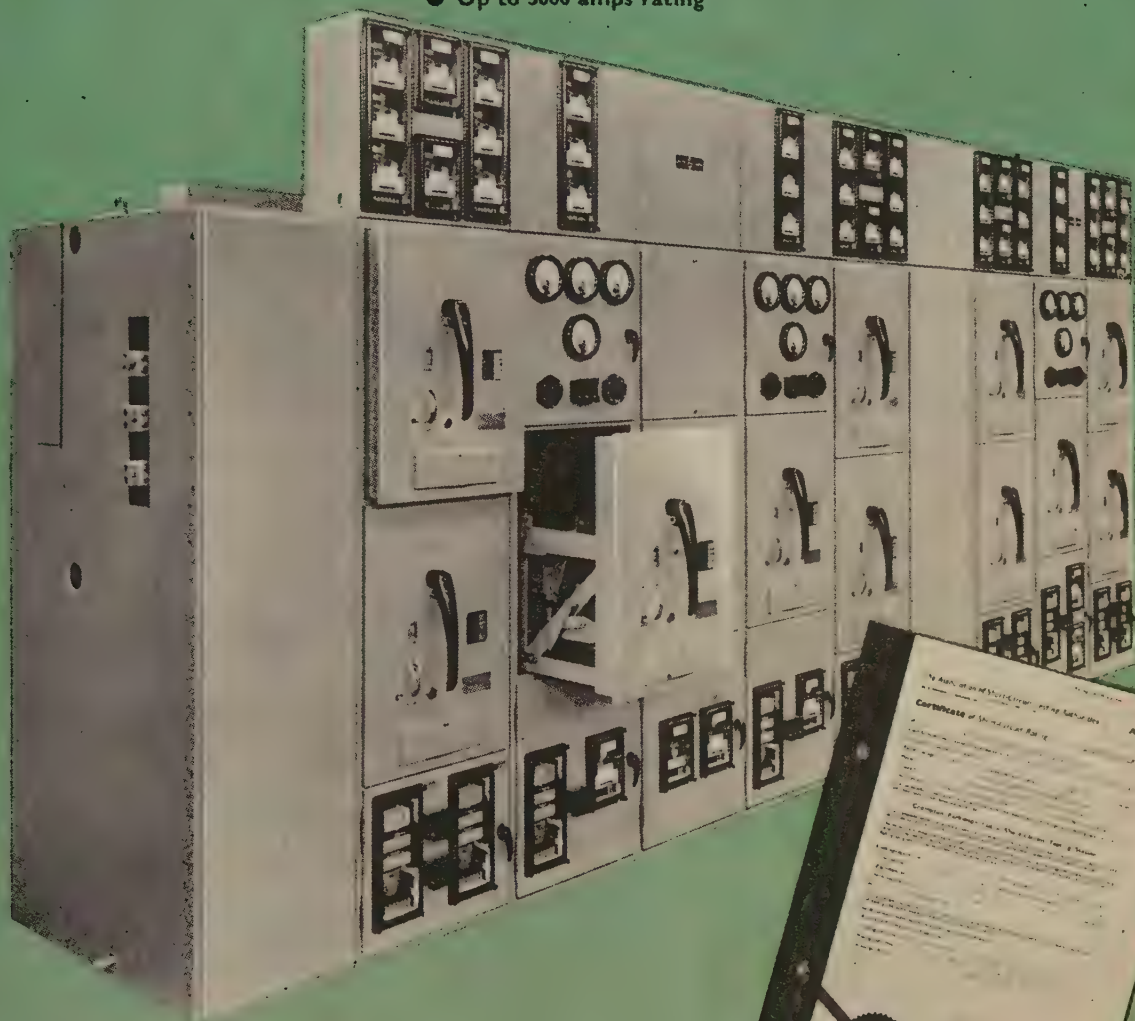
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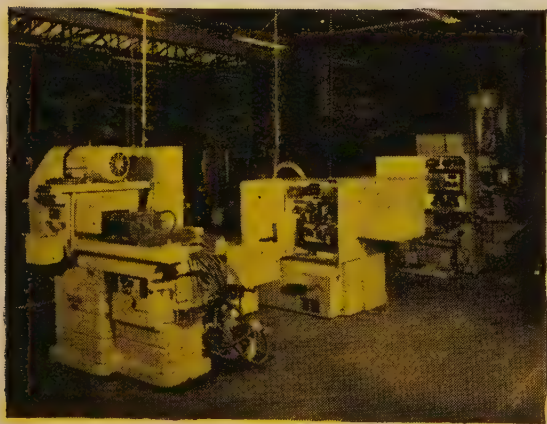
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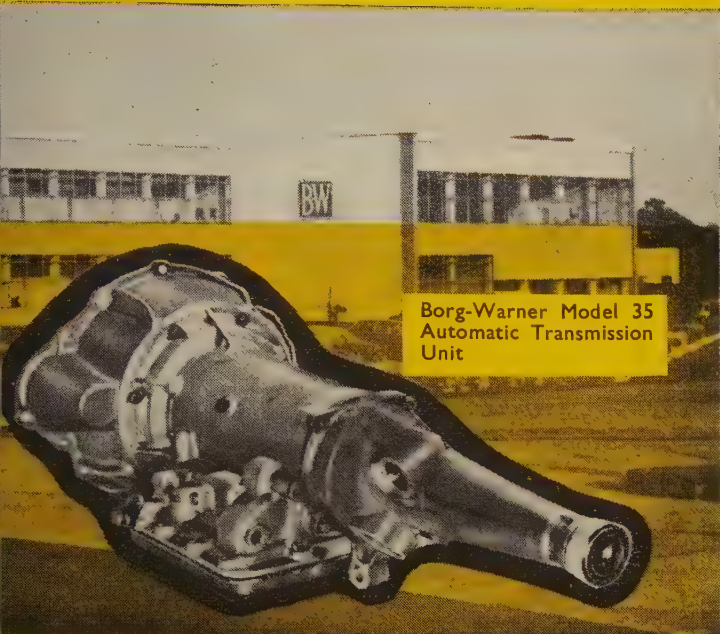
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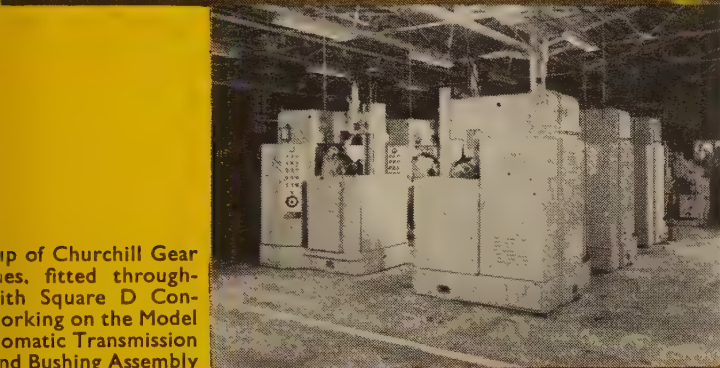
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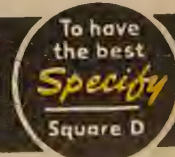
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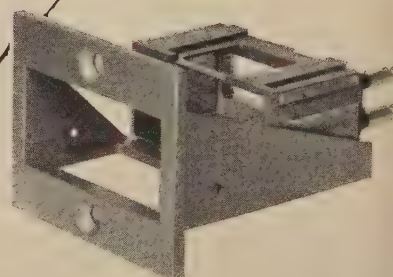
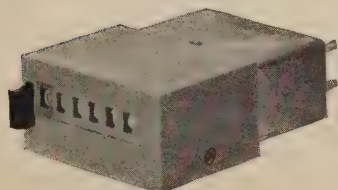
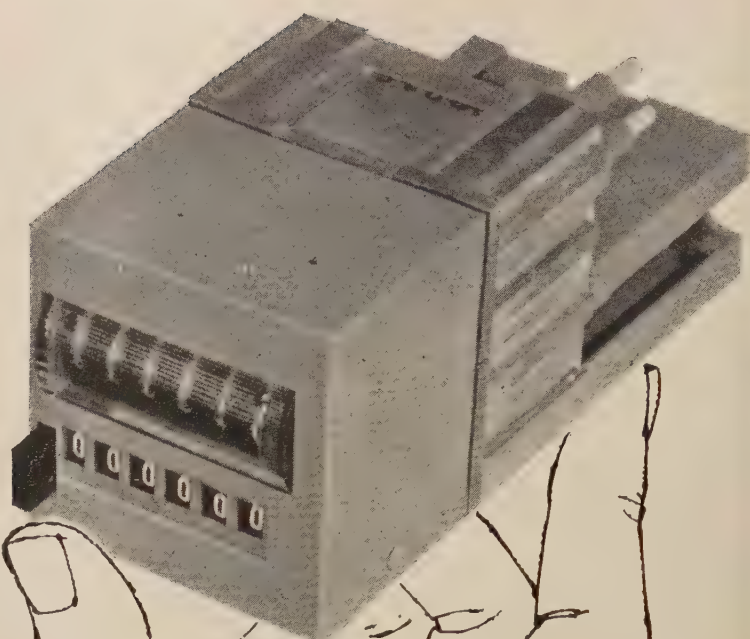


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VIEWS on the NEWS

By "REFLECTOR"

THE well-chosen programme at last week's B.E.A.M.A. Publicity Conference provided much food for thought. But it is disturbing to find that there are still many publicity managers (and their companies) who are only dimly aware of the changes in outlook that present-day conditions in the electrical industry demand. Everyone is pleased at an opportunity to obtain free advice from an expert and, not surprisingly, the practical sessions on printing techniques and on the law in relation to advertising were the most lively. The panel discussion, "What Would You Do?" was less successful. After having stressed the importance of not being dictated to by an advertising agency and having talked of public relations in less than complimentary terms, delegates found that their questions were answered by speakers engaged in these two activities. Next year, I think, the B.E.A.M.A. Publicity and Exhibitions Committee might put itself on the platform and invite specific questions about its past and future work.

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After listening to an instructive session at the Conference on the image which a company or organisation presents to the public—or more simply its reputation—I was interested to find the *Electrical Review* in last week's leader dealing with the same subject in relation to the electricity supply industry. The desirability of a good reputation both for its effect on sales and on the morale of employees cannot be overestimated. Of course, a poor reputation may be quite unjustified and based on some aspect of a company's methods that could easily be put right. Many organisations clearly have little idea what the public think of them and their products and attempts to find out can be revealing and instructive. For instance, I am told that as a result of its prominent advertisements on transmission lines the C.E.G.B. has received many letters from consumers concerning matters that are the responsibility of their local Area Boards. This confusion about the functions of the different bodies in the electrical industry is damaging and I am not surprised to learn that the organisation chart prepared by the Electricity Council is its best selling publication.

* * *

Meters accessible from the exterior of houses are widely installed in the United States but the idea has not caught on here. *Area Topics*, the North Western Electricity Board's magazine, attributes this to "various technical reasons" and to the fact that any outsider can see how much energy is being used (as if that really matters).

Anyhow, the North Western Board is to try it out. It is offering private builders and local authorities the opportunity of incorporating in an outside wall a cupboard containing a meter, service fuse, consumer's fuses and maybe a time switch.

"The meter itself will be fixed on a small hinged section, which allows it to be mounted in the normal manner and also lets it swing towards a letter box type opening in the outside brickwork. The viewing assembly unit would be a metal frame with a glass or Perspex plate on the inside and a weatherproof, hinged flap on the outside."

It will be interesting to see whether the scheme will be adopted or whether builders will consider it prejudicial to the sale of their houses.

* * *

Protesting against the web of electrical transmission lines linking the C.E.G.B.'s huge power stations, Mr. Gerald Haythornthwaite says in a letter to the *Guardian*:

"The advanced gas-cooled reactors now under development at Windscale, coupled with the new air-cooling towers at Rugeley, would provide a footloose power unit."

I can see what he means: he thinks that air-cooling methods would do away with the need for large supplies of cooling water. But his way of putting it does make it look like a long-distance cooling system. Mr. Haythornthwaite goes on to visualise smaller, local, independent power stations consisting of a combination of reactors and dry cooling towers.

* * *

Eighty years ago the incandescent lamp was beginning to make inroads into the sphere of the electric arc. It was not yet wholeheartedly accepted, for a correspondent to the *Electrical Review* of 15th November, 1881, referring to the new lamp, said that "Manchester people are not given to spending money on any useless novelty that may be introduced." Nevertheless, the journal itself reported:—

"We hear from various sources that the incandescence lamps have been so far improved that they can be made to give a light exceeding 600 candle-power without breaking the filament; this being the case, and in view of the further improvements which are certain to take place, it seems highly probable that the days of the arc lamps, for general lighting purposes, are numbered. It is a fact that many of our most eminent electricians, who are acknowledged authorities on the electric light question, and who in the first instance strongly argued in favour of the arc system, have now as strongly declared against it in favour of the incandescence principle."

PERSONAL AND SOCIAL

News of Men and Women of the Industry

In last week's issue we reported changes in the technical directorate of the British Standards Institution. We mentioned that **Mr. J. F. Stanley**, M.I.E.E., F.I.E.S., had become deputy technical director (electrical). Mr. Stanley has been with the B.S.I. (and its predecessor the British Engineering Standards Association) since 1922 and he represents the Institution on many outside organisations, including the I.E.E. Wiring Regulations Committee. He has also been active in the inter-



Mr. J. F. Stanley

Mr. P. Bingley

national sphere; since 1947 he has been secretary of the British National Committee of the International Electrotechnical Commission and he has been a delegate to the International Commission on Rules for the Approval of Electrical Equipment (C.E.E.).

Mr. P. Bingley, A.M.I.E.E., who is now a divisional chief technical officer, joined the B.S.I. in 1953 and is well-known to the many B.S.I. and I.E.C. committee members interested in switchgear, transformers, rotating machines and flameproof enclosures. Mr. Bingley's early experience was in the electrical contracting industry but after war service with the Royal Corps of Signals he became a power engineer, specialising in all types of static converters. He was awarded the I.E.E. Swan Premium in 1952 for a paper on mercury-arc rectifiers applied to variable-speed drives.

The English Electric Co., Ltd., has made the following appointments in its Control Gear Division at Kidsgrove, Stoke-on-Trent:—Chief development engineer, **Mr. F. E. Waspe**, A.M.I.E.E.; chief control engineer, **Mr. G. H. Gunnell**, A.M.I.E.E.; and chief design engineer, **Mr. E. J. Pepper**, A.M.I.E.E. These new appointments are intended to "streamline" the division's research and development programme for multi-motor control centres, variable speed

drives, static switching and control gear for machine tool drives and industry in general.

Mr. Waspe joined the company as switchgear contracts engineer at Stafford works in 1948 and has also served there as applications engineer in the Metal Industries Division and as industrial control engineer at the company's Bradford works.

Mr. Gunnell started as an apprentice in 1940 and was employed by the special engineering section at Stafford from 1954 to 1956 before transferring to Kidsgrove. He has worked on magnetic slip couplings, power station auxiliary drives and test plant including the R.A.E. Farnborough high speed wind-tunnel.

Mr. Pepper, who joined the company in 1945 as an engineer apprentice, served as a laboratory engineer in the Industrial Electronics Division at Stafford before moving to Kidsgrove in 1955 to become design engineer and subsequently section engineer in the magnetic amplifier field. During the course of this work he was responsible for the development and design of magnetic amplifiers for industrial controls particularly in steel mill application.

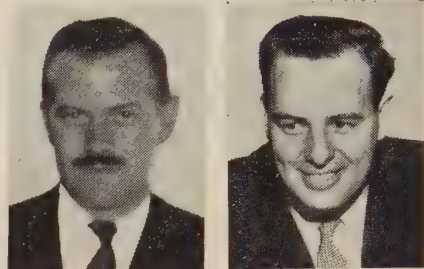
Mr. W. T. Marchment, for 15 years divisional manager of the Instrumentation and Controls Division of Evershed & Vignoles, Ltd., has been elected a director of the company. **Mr. Marchment**, who is a past-chairman of B. I. M. C. A. M., has been particularly active in petroleum re-



Mr. W. T. Marchment

finery electronic controls. A paper on electronic control in oil refineries which he presented a decade ago before the Instrument Society of America laid the foundations for a great deal of the work which has been done in this field. **Mr. Marchment** also introduced the electronic repeater system of measurement transmission, the "Noflote" pump control unit, and a number of other devices.

Mr. D. J. Venning has been made sales director of New Electronic Products, Ltd., an associate company of Honeywell Controls, Ltd. He will be



Mr. D. J. Venning

Mr. J. L. Lunn

responsible for sales of medical, industrial and scientific electronic equipment for N.E.P. in the U.K. and abroad. **Mr. Venning** has been micro switch sales manager at Honeywell since 1955 and is succeeded in this post by **Mr. J. L. Lunn**, who has specialised in micro switch sales with the company since 1956.

A popular occasion in the lighting industry is the annual dinner of the **Lightmongers' Society** and this year's function, in the Livery Hall of the Guildhall, London, on 7th November, was again a great success, attended by more than 150 members and guests. Following the dinner, the toast to "The Lightmongers" was proposed by **Dr. W. E. Harper**, M.I.E.E., F.I.E.S., who, as a technologist, spoke of the relationship between the technical and commercial sides of the lighting industry. He said that unless the industry was ready to give greater support than it was doing at the moment to promoting technical interests then it would be faced with a situation where the technology of lighting could be dictated by the architect or the electrical engineer. Such a result would not only be detrimental to good lighting but also to the welfare of the lighting business. At the moment, he said, the industry was burdened with too many technical bodies and



Mr. R. V. Stevens inducting Mr. C. Dykes-Brown as president of the Lightmongers' Society

organisations and he looked forward to the day when it could speak with one voice. Mr. R. V. Stevens, president of the Society, responded. Mr. C. Dykes-Brown, F.I.E.S., who proposed a toast to "The Guests," paid special tribute to Dr. Harper for his work in connection with the I.E.S. Code. In proposing the health of the president, Mr. Dykes-Brown thanked Mr. Stevens, a founder member, for his work during his year of office. Mr. Stevens in his reply recognised the loyal support he had received from officers of the Council. He then invested Mr. Dykes-Brown, his successor, with the presidential badge.

During the course of the evening cheques towards the funds of the Royal Commercial Travellers' Schools and the Electrical Industries Benevolent Association were presented by the president on behalf of the Society. It was also announced that Mr. T. Catten would shortly be retiring as social secretary because of ill-health. Mr. V. G. E. Gardner has been appointed as his successor.

Mr. Robert Hall has been appointed divisional general manager of divisions and associate companies within the Plessey Swindon Group. They are the Units and Parts Division and Sheet Metal Unit of the Plessey Co., Ltd., as well as Power Auxiliaries, Ltd., and Machine Products, Ltd. Mr. Hall was previously commercial executive



Mr. R. Hall

for the Swindon region.

Mr. J. A. Enwright has been appointed a director of the Wayne Kerr Engineering Co., Ltd., and **Mr. G. L. Ball**, B.Eng., A.M.I.E.E., has been appointed sales director of Wayne Kerr Laboratories, Ltd.

Mr. Enwright joined Wayne Kerr as sales and contracts manager in 1953 and was appointed general manager in 1955. Mr. Ball has been general sales manager since 1958; previously he was sales manager of the Plessey Swindon Components Group for three years and before that he was with the Telegraph Condenser Co., Ltd., and Standard Telephones & Cables, Ltd.

Mr. L. D. Gunnell, executive director of Foster Electrical Supplies, Ltd., is retiring at the end of the year but will continue his association with the company as consultant. Mr. Gunnell has been connected with the wholesale distribution branch of the industry for

over 50 years. He joined Foster Electrical Supplies in 1921 as a sales representative and two years later opened the Birmingham branch. In 1932 he was appointed sales manager and in 1955 was elected to the board as executive director.

Mr. L. G. Lewzey, M.C., T.D., F.C.I.S., F.I.E.S., has been appointed



Mr. L. G. Lewzey

secretary of the A.E.I. Lamp & Lighting Co., Ltd. Mr. Lewzey joined the export section of Metrovick Supplies, Ltd., in 1928, and two years later moved to the lamp department head office of the Metropolitan-Vickers Electrical Co., Ltd.; he was later responsible for industrial lighting application and design. After war service with the Royal Artillery he returned to Metrovick. In 1958 he was appointed assistant secretary and assistant controller of the A.E.I. Lamp & Lighting Co. In addition, Mr. Lewzey has been secretary of British Sealed Beams, Ltd., since 1959. He is a past-chairman and council member of the Field Survey Association and a past council member of E.L.F.A. and E.D.L.A.C.

Mr. E. W. Herring, A.C.I.S., at present district administrative officer of the London Electricity Board's West End District, has been appointed to succeed **Mr. T. Porter** as district administrative officer of the South Western District on his retirement. Mr. Herring takes up his new duties on 1st January.

The annual ball of the **Ipswich and District Electrical Association** was held at the Royal Hotel, Clacton-on-Sea, on 3rd November, and was attended by about 240 members and guests. The guests were received by the president, Mr. H. V. Pugh, and the chairman, Mr. R. W. C. Stebbings, and their ladies. (Mr. Pugh is chairman of the Eastern

Electricity Board and Mr. Stebbings commercial officer, Suffolk Sub-Area.) Among those present were Sir Charles and Lady Westlake and other distinguished guests, some of whom had travelled from the Midlands and Southern England to be present.

Mr. G. N. Leech, B.Sc., A.M.I.E.E., has been appointed chief engineer, power transformers (Rugby), in the Transformer Division of Associated Electrical Industries, Ltd. A native of Belfast, Mr. Leech served a graduate apprenticeship at the British Thomson-Houston Co.'s Rugby Works and subsequently joined the Transformer Engineering Department. He was appointed assistant chief engineer, Transformer Engineering Department, Rugby, in 1959.

Mr. K. W. McBain, M.I.Mech.E., M.I.E.E., Mem.A.I.E.E., has been appointed chief engineer of the Micanite & Insulators Co., Ltd. Until this appointment Mr. McBain was divisional executive member (Rugby) and chief engineer of the Transformer Engineering Department, Rugby, of the A.E.I. Transformer Division.



Mr. K. W. McBain

He was for many years in charge of the large high-voltage transformer, rectifier transformer and miniature transformer sections of the B.T.H. Transformer Engineering Department, which he joined in 1924, and he was appointed manager of the Department in 1950. Mr. McBain has served on a number of technical committees, both within the British transformer industry and internationally.

Mr. A. H. Campbell, C.A., has been appointed chief financial officer of the Central Electricity Generating Board. Mr. Campbell joined the former Central Electricity Board in 1932 and

At the Ipswich and District Electrical Association's annual ball: Mr. and Mrs. R. W. C. Stebbings, Mr. and Mrs. W. E. Wardrop, and Mr. and Mrs. H. V. Pugh



was later with the Yorkshire Electric Power Co. group. In 1948 he became divisional accountant of the Merseyside and North Wales Division of the British Electricity Authority and in 1958 he was appointed deputy chief financial officer at C.E.G.B. headquarters.

Changes in the board of the Rheostatic Co., Ltd., have been announced. Because of increased managerial responsibilities within the Elliott-Automation Group as a whole, **Mr. M. J. Gartside**, while remaining chairman of the Rheostatic Co., relinquishes his appointment as managing director. He is being succeeded in this position by **Mr. J. H. Stevens**, who has for many years been a director and the general manager of the company. It is also announced that **Mr. Hemsley C. F. Miller**, who has been associated with the Rheostatic Co. since its foundation 40 years ago, has retired for reasons of health and that **Mr. E. O. Herzfeld**, director of Elliott-Automation, and **Mr. G. C. Fairbanks**, director of Elliott Brothers (London), Ltd., have joined the board.

Mr. J. E. Mitchell, B.Sc.Tech., M.I.E.E., M.I.Mech.E., the city electrical engineer of Salisbury, Southern Rhodesia, is leaving in January to become the general manager of the Rhodesia Congo Border Power Corporation, Ltd.

The annual dinner of the Midland Branch of the **Electrical Trades Commercial Travellers' Association** was held recently in Birmingham. There was a good attendance and an excellent response was made to the collection for charity. **Mr. H. Bowen**, hon. general secretary, proposed the toast to the E.T.C.T.A., to which **Mr. G. W.**



Mr. J. H. Stevens



At the E.T.C.T.A. Midland Branch dinner (left to right): **Mr. S. W. Graefe** (immediate past chairman), **Mr. G. W. Arnold** (chairman) and **Mr. A. R. Leith** (president, Birmingham Electric Club)

E.I.B.A. BALL (See facing page)

LAST Friday's Electrical Industries Ball at Grosvenor House, London, W., organised by the Electrical Industries Benevolent Association, attracted about a thousand people among whom one recognised many of the electrical industry's leaders. **Mr. R. A. Marryat**, president of the E.I.B.A., accompanied by **Mrs. Marryat**, received the guests and during the proceedings **Mr. Marryat** read out a message which had been sent to the Queen, as patron of the Association, and her reply.

There was the customary collection for the funds and a draw for about forty prizes generously presented by electrical and allied firms. A cabaret show added to the evening's enjoyment.

As a result of the ball the Association's funds were augmented by nearly £2,000.

Arnold, branch chairman, replied. **Mr. W. H. Tilley**, J.P., president of the Birmingham Law Society, responded to the toast of the guests given by **Mr. G. A. James**.

The Yorkshire Electricity Board has made the following appointments:—**Mr. H. Pickup**, B.Sc.Tech., M.I.E.E., at present sub-area engineer, No. 5 (Wakefield) Sub-Area, to be manager, No. 2 (Huddersfield) Sub-Area; **Mr. W. E. B. Nettleton**, M.I.E.E., manager, No. 5 (Wakefield) Sub-Area, to be manager, No. 3 (Sheffield) Sub-Area; **Mr. J. S. Yates**, M.I.E.E., deputy chief engineer, to succeed **Mr. Nettleton** as manager, No. 5 (Wakefield) Sub-Area; **Mr. G. L. Tomlinson**, A.M.I.E.E., sub-area commercial officer, No. 3 (Sheffield) Sub-Area, to be manager, No. 7 (Grimsby) Sub-Area; and **Mr. E. Cockroft**, A.M.I.E.E., sub-area engineer, No. 7 (Grimsby) Sub-Area, to be sub-area engineer, No. 5 (Wakefield) Sub-Area.

In this issue the Yorkshire Board is inviting applications for a number of appointments, including those of deputy chief engineer; sub-area commercial officer, No. 3 (Sheffield) Sub-Area; and sub-area engineer, No. 7 (Grimsby) Sub-Area.

OBITUARY

Mr. E. P. Grimsdick, who died on 27th October, was with the Associated Electrical Industries, Ltd., group of companies for 59 years, and for 48 years played an important part in the industrial development of India. He joined the Edison Swan Co. in 1899, becoming chief of the Test Department, and commenced his association with the British Thomson-Houston Co. in 1905. He served in the Central Station Department for five years then went to India where he was in charge of contract erection work until 1924 when he was appointed the first managing director of B.T.H. (India), Ltd. In 1931 A.E.I. (India) was

created to amalgamate the interests of B.T.H. (India) and the Metropolitan-Vickers Export Co.'s offices in India, and **Mr. Grimsdick** became chairman and managing director of the new company. On his retirement from India in 1937 he relinquished executive control but remained chairman until 1955 of A.E.I. (India) and its subsidiary, the A.E.I. Manufacturing Co. After the partition of India he became chairman of A.E.I. (Pakistan). **Mr. Grimsdick** revisited India on a number of occasions and took part in the original discussions and negotiations with the Government of India on the heavy electrical plant project. During the years 1945-54 he was assistant to the managing directors of A.E.I., chairman of the International Refrigerator Co. and a director of A.E.I.-Hotpoint and of Ferguson Pailin. In 1954 he joined A.E.I. Overseas and on retirement a year later was retained in a consultative capacity on matters concerning A.E.I.'s operations in India and Pakistan before relinquishing this appointment in 1958.

Mr. R. D. MacMillan.—The death occurred on 8th November of **Mr. Robert Davidson MacMillan**, managing director of Controlled Heat & Air, Ltd. **Mr. MacMillan**, who was 57, joined the company as chief designer in 1933 and was appointed managing director in 1945.

Mr. J. Myers.—The death occurred recently of **Mr. John Myers**, senior representative for dielectric generators in the electro-heating group of Research & Control Instruments, Ltd. He had been with the Philips organisation selling high-frequency generators since 1952.

Mr. Harvey Slocum, the American engineer who was acting as consultant for the Bhakra Dam in the Punjab, died on 11th November at the site of the dam. He was seventy-five.



ABOVE: 1. Sir Robertson and Lady King being greeted by Mr. R. A. Marryat (president) and Mrs. Marryat. 2. Mr. and Mrs. C. T. Melling. 3. Mr. and Mrs. H. V. Pugh. 4. Mrs. J. Irens with Mr. and Mrs. A. N. Irens. 5. Mr. and Mrs. J. Mortimer Hawkins. 6. Mr. and Mrs. R. R. B. Brown. 7. Dr. and Mrs. R. Beeching (on the left Mr. H. Senior Fothergill, secretary, E.I.B.A.). 8. Mr. and Mrs. W. A. Gallon. 9. Mr. and Mrs. E. A. V. Peckham

BELOW: 10. This B.E.A.M.A. group includes the president, Mr. A. M. Browne, and the director, Mr. Stanley F. Steward. 11. At this table are Sir Charles and Lady Cunningham, Mr. and Mrs. C. T. Melling, Mr. and Mrs. J. I. Bernard and Mr. T. E. Daniel. 12. Mr. R. E. V. Ely's table: the guests include Sir Harold and Lady Bishop and Mr. and Mrs. A. H. Olson. 13. Mr. and Mrs. D. D. Walker, with Sir Mark and Lady Turner and Mr. and Mrs. R. Harter



INDUSTRIAL NEWS

CO-OPERATIVE PUBLICITY OVERSEAS

UNDERLINING the need for more co-operation in selling overseas, Mr. H. G. Nelson, managing director, the English Electric Co., Ltd., told the B.E.A.M.A. Publicity Conference last week that the greatest efforts of British firms in export markets were often absorbed in competing among themselves and not in meeting foreign competition.

Mr. Nelson, who was guest of honour at the final luncheon, filled in the background to the earlier discussions by giving delegates an extremely able and balanced summary of the problems confronting the industry.

He emphasised the need for facing up to, and learning to live with, the factors that were producing the changing pattern of trade both overseas and at home. The first priority was to reduce costs and this meant approaching old problems from a different angle. It did not mean reducing quality or wages but manufacturers should ensure that they got the best for what they did pay. They must also study the structure of the industry and ask themselves whether they could afford to have so many separate companies engaged in it. There was room, he said, for improving the industry's reputation for delivery and service and for more forceful and imaginative selling. They should also take good care, as Continental firms were doing, to ensure the background of a healthy home industry. Two things they should not do were to reduce their research and development effort and traditional standards of quality. They must, however, study the efficiency with which research was carried out

and stress value for money in selling. Only by all pulling together, Mr. Nelson concluded, would the industry surmount its difficulties.

The benefits of bringing the publicity section into the planning of sales and marketing at an early stage were stressed by Mr. G. M. C. Peacock, publicity manager, Babcock & Wilcox, Ltd., and chairman of the B.E.A.M.A. Publicity and Exhibitions Committee. Later delegates were given an example of how this had been achieved in the case of A.E.I.-Hotpoint, in a talk by the company's marketing director, Mr. C. A. Ganderton.

Mr. Peacock also referred to the "agonising reappraisal" necessary if the electrical industry was to assert itself in a huge and competitive European market when most of its previous export experience had been of trading within the Commonwealth and at the same time was to hold its own against the flood of European

competition. This, he said, would drive even the "Little Englanders" in the industry to a new appraisal of their production, publicity and marketing arrangements if they were to survive, even at home.

That there is much scope for collective publicity activities by electrical firms in overseas markets, and some misunderstanding of what is involved, was made clear in the discussion session led by Mr. M. L. G. Balfour, export publicity and fairs officer, Board of Trade, and Mr. C. T. M. Bagnall, manager, publicity and information services, English Electric Co., Ltd. Mr. Balfour emphasised that the Government could not sell for industry but could help in preparing the ground. Collective efforts, Mr. Bagnall said, might be of particular value in influencing the laymen whose opinion counted for so much in placing contracts for capital plant. The days were gone when engineer negotiated with engineer alone. Financial, political and economic considerations were now brought to bear by "men impervious to purely technical arguments."

POWER STRIKE THREAT

A warning that unless a more satisfactory reply to their claim for £2 a week increase was received there might be a strike of power station members, was given at a meeting last Friday of three of the unions concerned—the Transport & General Workers, the General & Municipal Workers and the Enginemen, Firemen, Mechanics & Electrical Workers. The meeting rejected the employers' offer of certain improvements in wages and

conditions to begin to take effect next April. Sir Thomas Williamson (General & Municipal Workers) said after the meeting that his executive would meet this week but that no recommendation for a strike would be on the agenda.

The Electrical Trades Union has already announced its support of strike action if it becomes necessary and the Amalgamated Engineering Union is also sympathetic to the proposal.

S.T.C. Acquires Telephone Equipment Companies

Standard Telephones & Cables, Ltd., has acquired the share capital of Phoenix Internal Telephone Systems and Private Telephone & Electric Co., both previously owned by Phoenix Telephone & Electric Works, Ltd., of The Hyde, Hendon. The business of these two companies is the hire and maintenance of private telephone equipment and this will be continued by the Private Communication Division of S.T.C. The directors of the new subsidiaries are Mr. A. D. Mackay, finance director, S.T.C. (chairman) and Mr. J. F. Hitchcock, general manager, S.T.C. Private Communication Equipment Division.

Office Lighting Display



This effective window display was designed by the Yorkshire Electricity Board and installed at its Headrow Service Centre, Leeds, in connection with the office lighting exhibition organised by the British Lighting Council (Leeds, 31st October to 2nd November)

E.T.U. Executive Council Elections

THE results of the elections for the new Executive Council of the Electrical Trades Union which will take office at the end of the year were announced on Sunday by the general president, Mr. Frank Foulkes, after a special meeting of the Executive at Union headquarters. They showed that Communists and their supporters had suffered a heavy defeat and retained only two of the eleven seats against eight at present. The two are Mr. J. McKernan (Belfast), who was returned unopposed, and Mr. H. West who is not a Communist but has consistently voted with the present majority on the Executive. The new members are Messrs. T. Breakell (Preston), J. Sharman (Northampton), J. O'Neil (Portishead), L. Tuck (London), H. Gittins (London) and W. Blair (Ruislip) who defeated Messrs. J. Feathers, S. Goldberg, I. Davies, R. A. Sell, J. Frazer and J. Hendy.

Mr. Foulkes said that the total poll was 49,173 out of a membership of 250,000, although a considerable number of members were probably in-

eligible to vote because of arrears. The 20 per cent poll was substantially higher than at previous Executive elections. The votes from 35 of the 702 branches were disqualified for one reason or another. He doubted if the result would have been the same if the Press had not used its influence in the way that it had done.

He said he did not know all the new members personally, but he thought any decision they might make would

be taken in the best interests of the members, which would be their main concern.

This year's elections were the first to be supervised by a firm of chartered accountants.

On Monday the solicitors for Mr. Frank Chapple stated that a High Court writ had been served on Mr. R. G. McLennan (acting general secretary in the absence through illness of Mr. John Byrne) seeking an injunction to restrain the Union from holding its Rules Revision Conference, due to begin at Hastings next Tuesday.

Brazil to Build 300 MW Nuclear Station

THE Brazilian Government, through the Comissao Nacional de Energia Nuclear (C.N.E.N.), is to build a 300 MW nuclear power station in the central-southern region of Brazil to supply power to the State of Guanabara. The station will have a single reactor of the gas-cooled, natural uranium, graphite moderated type.

In an advertisement asking for the names of firms interested in tendering, C.N.E.N. say it is their intention to "execute part of the project within battery limits with a sole contractor on an integrated responsibility basis,

for a fixed price." It is explained that the part of the project within battery limits means the major portion of the whole work in connection with the design and construction of the station.

The services and responsibilities to be undertaken by the sole contractor will include all the design work, purchasing, inspection, expediting, supervision of the construction, construction, start-up and commissioning of the station. The contractor will be expected to make full use of Brazilian industry and capabilities and to provide financial assistance.

Approved Domestic Appliances

COINCIDING with the completion of the first year of operation of the British Electrical Approvals Board for Domestic Appliances (B.E.A.B.) is the announcement of a further list of approved electrical appliances. Radiant fires, vacuum cleaners, kettles, shavers, toasters, wash boilers, coffee percolators, irons, hair dryers, immersion heaters and refrigerators are now in the scheme and the B.E.A.B. is able to accept at any time applications for approval of any of these types of appliances. As soon as specifications (in the B.S. 3456 series) are available the following further types of appliances will be dealt with:—Cookers, carpet underlays, room heaters, water heaters, drying cabinets, floor polishers, ironing machines, spin and tumbler dryers, washing machines, dish washers, warming plates, and food mixers.

The B.E.A.B. in its first year received 549 applications, of which 67 were withdrawn. Of the net figure of 482 applications, approval has been granted to 255. This does not mean that the others have irrevocably failed, since modified samples are constantly being re-submitted.

The third supplement to the 1961 list comprises radiant fires (ten manufacturers), toasters, vacuum cleaners, wash boilers and kettles.

COLSTON AND ROLLS AMALGAMATE

Charles Colston, Ltd., manufacturers of the "Colston" dish-washing machine, are to join forces with Rolls Razor, Ltd., manufacturers of the "Electromatic" washing machines. A new company, with a share capital of £250,000, is to be set up with the provisional name of Rolls-Colston Appliances. Sir Charles Colston will be chairman and joint managing director and Mr. John Bloom, now managing director of Rolls Razor, joint managing director. The dish-washers will no longer be sold through retailers as at present, instead they will go direct to the public at a price in the region of £60. The present price is £99 15s.

Charles Colston will retain the export rights and the existing service organisation will remain in being to provide service and spare parts for existing customers. All Colston branch offices, however, will be closed and

selling will be carried on through the Rolls organisation.

The new company is also intending to enter the cut-price retailing field with "discount stores." The first of these is due to open at Ilford in January.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton	£186	0s	0d
COPPER, H.C. Electro	ton	£228	5s	0d
Fire Refined 99.70%	ton	£227	0s	0d
Fire Refined 99.50%	ton	£226	0s	0d
COPPER Tubes	lb	2s	3½d	
Sheet	ton	£266	0s	0d
H.C. Wire and strip	ton	£280	15s	0d
LEAD, English	ton	£57	5s	0d
Foreign	ton	£56	0s	0d
MERCURY	flask	£60	0s	0d
TIN, block (English)	ton	£965	0s	0d
ZINC, G.O.B. Foreign	ton	£67	5s	0d
BRASS Tubes (solid drawn)	lb	1s	9¾d	
Wire	lb	2s	8½d	
PHOSPHOR BRONZE				
Wire	lb	4s	2½d	
PLATINUM	oz	£30	5s	0d
RUBBER, No. 1 R.S.S. spot	lb	22½d—22d		

Sun Electrical Acquisition

The capital of H. W. Gilbert, wholesale electrical distributors, of Brentwood, Essex, has been acquired by the Sun Electrical Co., Ltd., for £32,500.

INDUSTRIAL NEWS *[continued]*

India Power Development Film

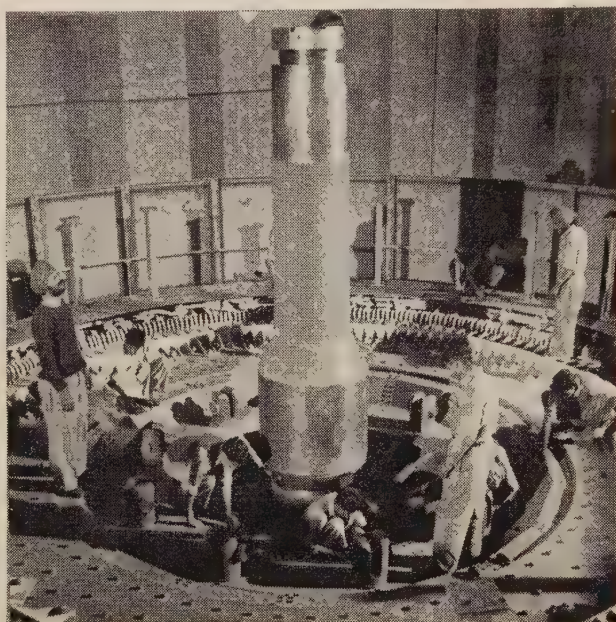
ELECTRIFICATION in India is advancing at an increasing pace. In the next five years it is planned to double the supply of electric power and in ten years to raise it sixfold. Equipment for the generating stations now under construction is being imported, but their counterparts of the 1970's will be built in India.

The background to this change and the effect that electricity is already

having on the pattern of life in India is beautifully portrayed in a new colour film produced by the A.E.I. Film Unit entitled "The Peaceful Revolution." At one extreme, forty thousand men and women are building a dam with their bare hands. At the other, 25,000 skilled tradesmen will be trained in ten years in the latest manufacturing techniques at the heavy electrical plant factory at Bhopal. This factory, for which A.E.I. were the consultants, will eventually

supply the bulk of India's needs for heavy electrical apparatus, worth £40 million a year. Switchgear and transformers are already in production and, later, water turbines, alternators up to 150 MW, electric motors and railway equipment will come into production.

Copies of the film (16 mm and 35 mm) are available on free loan from the A.E.I. Film Library, Crown House, Aldwych, W.C.2. It lasts 26 minutes.



Installing one of the 90 MW A.E.I. generators at Bhakra hydro-electric station. (A still from "The Peaceful Revolution")

TRADE OPPORTUNITIES IN JAPAN

THE belief that there is a great potential market for British products, especially engineering goods of all kinds, is expressed in an F.B.I. report "A Look at Japan" (price 10s) published this week.

The report is the result of a three-week visit to Japan by Sir Norman Kipping, director general, and Mr. John Whitehorn, deputy overseas director, Federation of British Industries. They are of the opinion that British industry is missing a valuable potential income because it is unwilling to enter into licence or know-how agreements with Japanese companies. Last year, there were 1,509 such agreements of which only 51 were British. Remittances to foreign companies in respect of such agreements have grown from under \$20 million in 1955 to \$81½ million in 1960 and \$70 million in the first half of this year.

The idea that withholding know-how

can retard the development of Japanese competition is an illusion, they state. In fact British unwillingness in this respect, coupled with a general ignorance of British engineering products and achievements, has led "to scepticism of our having much in the way of technology to sell." In the first nine months of 1961, British electrical exports to Japan were worth £683,801 against £600,466 in the corresponding period of 1960.

JAPANESE RAILCARS FOR ARGENTINA

The Argentine State Railways has completed negotiations with Tokyo Shibaura Electric Co. (Toshiba) and Marubeni-Iida Co., Ltd., for the purchase of 200 high speed electric cars. The order is worth \$18.5 million, to be paid eight years after completion, and it brings the total of Japanese electric cars for Argentine Railways to 416.

£330,000 Malayan Cable Contract

The British Insulated Callender's Cables Group has been awarded a £330,000 contract by the Central Electricity Board of Malaya for the supply and installation of some 60 miles of power, control and telephone cables for the Cameron Highlands scheme.

The cables will be installed by the British Insulated Callender's Construction Co., Ltd., at and between the Jor and Habu hydro-electric power stations and at Rawang substation and Connaught Bridge power station. They will include some three miles of 132 kV power cable installed in an inclined shaft to the underground power station, 25½ miles of 11 kV power cable and four miles of 660/1,100 V paper-lead and p.v.c. insulated power cables. In addition, the contract calls for approximately 27 miles of control, telephone and coaxial cables.

ELECTRICAL INDUSTRIES CLUB

Mr. E. A. V. Peckham, president, was in the chair at last Tuesday's luncheon meeting of the Electrical Industries Club at which Sir Frederick James, O.B.E., deputy chairman and managing director of Tata, Ltd., was the guest speaker. Sir Frederick, who has spent more than 25 years in India, gave his impressions of the country and a forecast of its future. He spoke of the success of its past two five-year plans. The third five-year plan, just beginning, would require a capital investment of approximately £8,000 million, of which 75 per cent would be derived from foreign aid. Of the amount received from private sources, 65 per cent would come from this country.

Following a vote of thanks to the speaker by the president, it was announced that the next meeting on 12th December would be a special Christmas luncheon at which the guest speaker would be Mr. Bernard Miles.

Census of Production

The Board of Trade has made an order prescribing the matters about which returns may be required for the Census of Production to be taken next year for the year 1961. This will be a sample inquiry and the questions asked will relate only to sales and work done, capital expenditure, and stocks and work in progress. The Order, which operates from 30th December, 1961, is the Census of Production (1962) (Returns and Exempted Persons) Order, 1961 (S.I. 1961 No. 2098), copies of which can be obtained from H.M. Stationery Office, price 3d.

Contactors



LONG SERVICE LIFE

The SLA range of contactors has a service life of between 10 to 15 million switching operations at up to 6000 operations per hour.

SMALL DIMENSIONS

$2\frac{1}{8} \times 1\frac{1}{8} \times 2\frac{1}{8}$ for a 6 Amp contactor and correspondingly small dimensions for higher ratings.

ACCESSIBILITY

For ease of wiring special consideration has been given in the design of these contactors for easy access to contacts and operating coil.

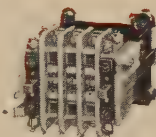
Backed by years of design and production experience the new range of STOTZ CONTACTORS may be supplied open or in metal or bakelite housings.



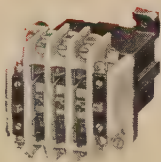
SLA 6
(6 Amp)



SLA 10
(10 Amp)



SLA 20
(20 Amp)



SLA 30
(30 Amp)



SLA 40
(40 Amp)



SLA 60
(60 Amp)

Other STOTZ products:—

- MINIATURE CIRCUIT BREAKERS
- RELAYS
- MICRO SWITCHES
- PRESSURE SWITCHES
- THERMOSTATS
- BALLASTS
- FLAME IGNITION CONTROL EQUIPMENT
- EXPLOSION AND FLAMEPROOF SWITCHGEAR

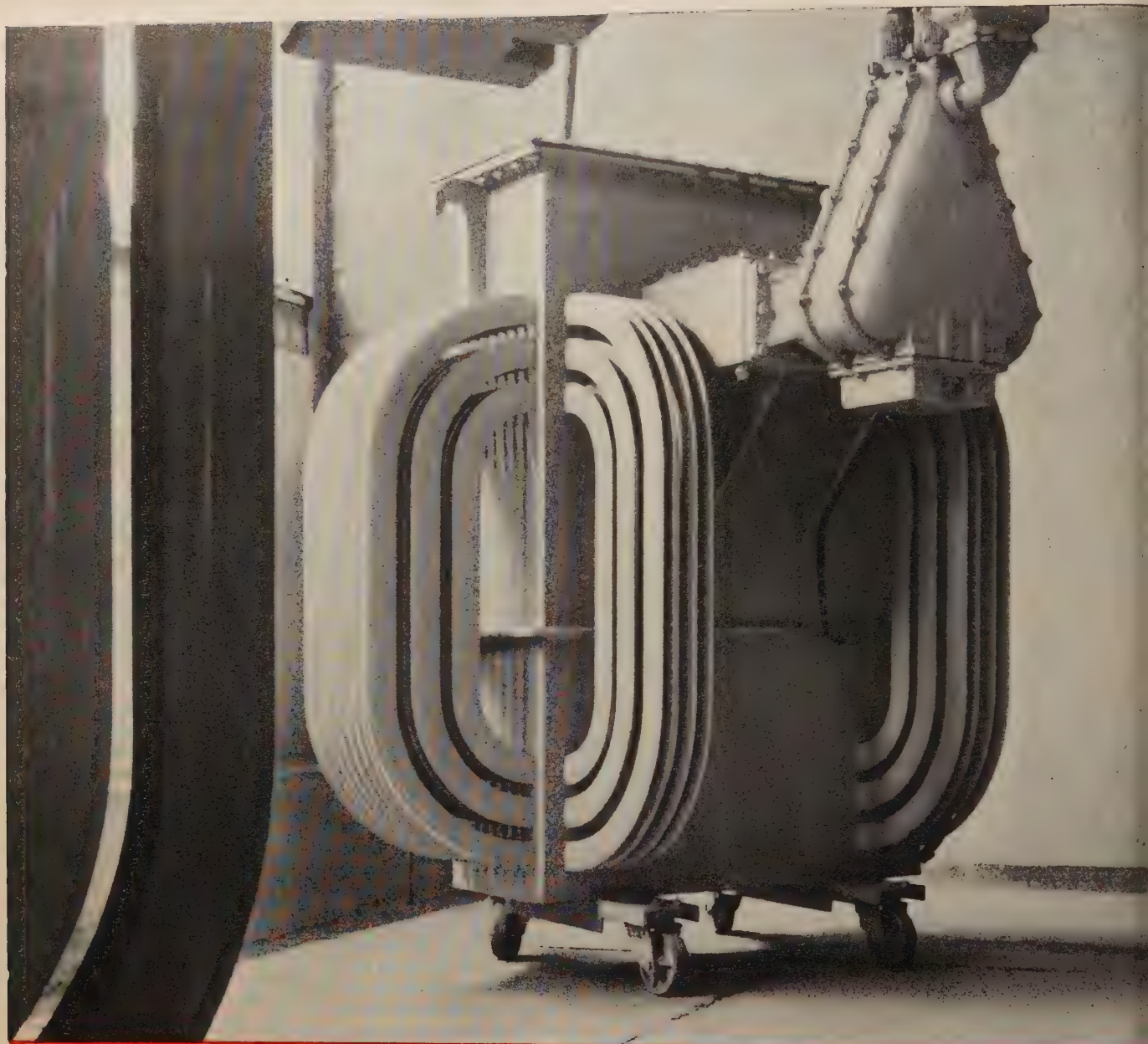
Write for details of our complete range of contactors to:—

BBB

BRITISH BROWN-BOVERI LTD.

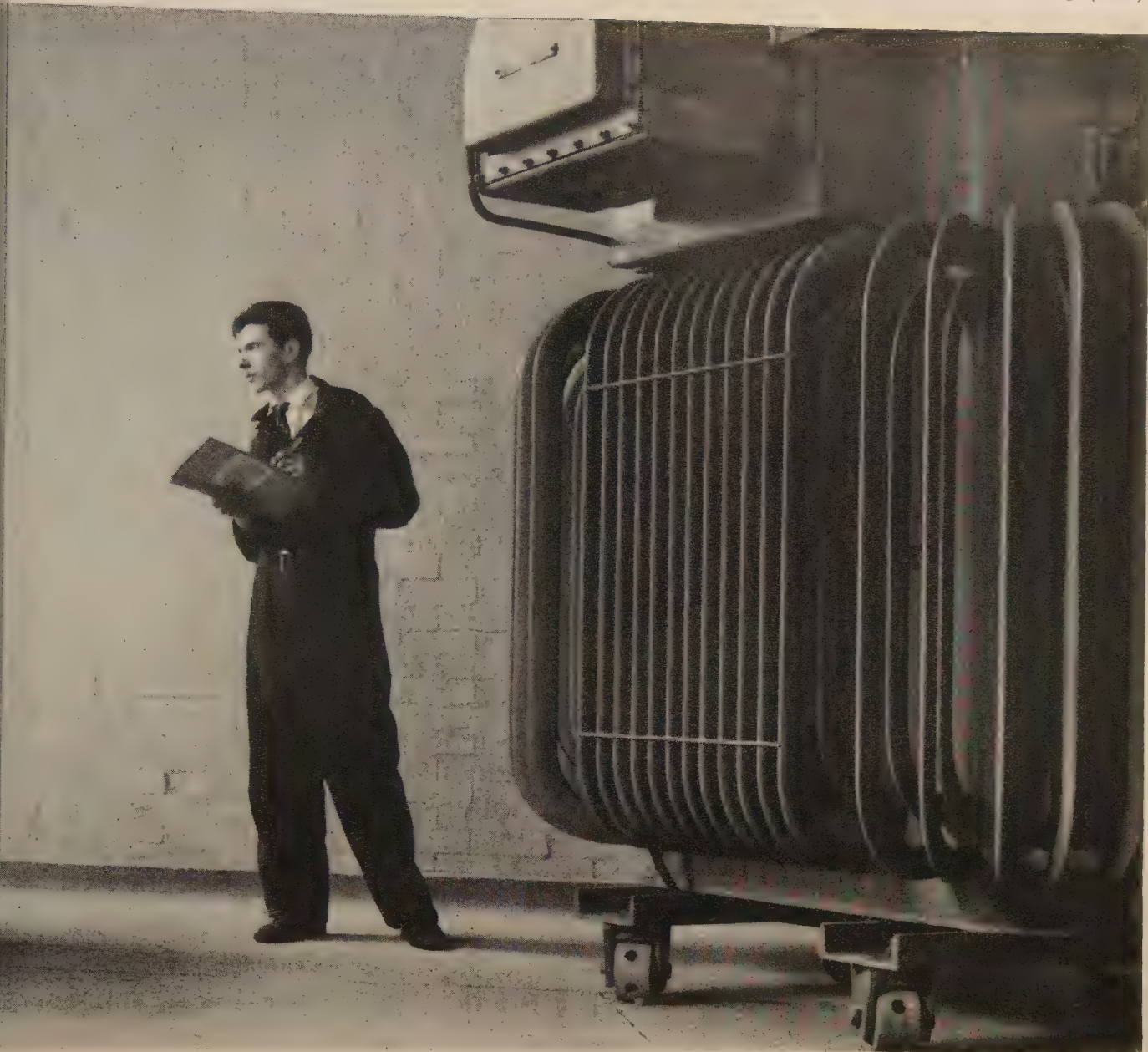
75 VICTORIA STREET, LONDON, SW1

Telephone: ABBey 5777 (3 lines) Telex No. 23448



PYROCLOR TRANSFORMERS

for new **G.P.O. building**



Pyroclor-filled transformers supplied by: Foster Transformers Ltd., South Wales Switchgear Ltd.



On Tuesday, 11th April, the Lord Mayor of London opened the G.P.O.'s Fleet Building at Farringdon Street.

SAFE-ANYWHERE TRANSFORMERS Pyroclor is fire-resistant, so transformers do not require special bunkers or fire-proof vaults. And there is no need for fire-fighting equipment.

TROUBLE-FREE TRANSFORMERS Pyroclor transformers give reliable service even in dusty, damp or corrosive atmospheres. What's more, maintenance demands are negligible.

SITED-ANYWHERE TRANSFORMERS Pyroclor transformers can be placed anywhere convenient. Sited at load centres they eliminate long, costly, low-tension runs and consequent voltage drop.

Distribution transformers with ratings from 50KVA to 3,000KVA and above. Write today for more information on Pyroclor.

PYROCLOR—SAFE, TROUBLE-FREE, CONVENIENT—TRANSFORMERS



Regd.

MONSANTO CHEMICALS LIMITED

976 Monsanto House, Victoria Street, London, S.W.1 and at Royal Exchange, Manchester 2.

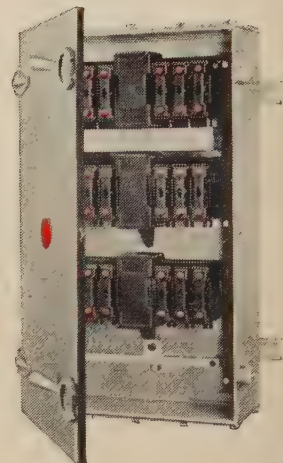
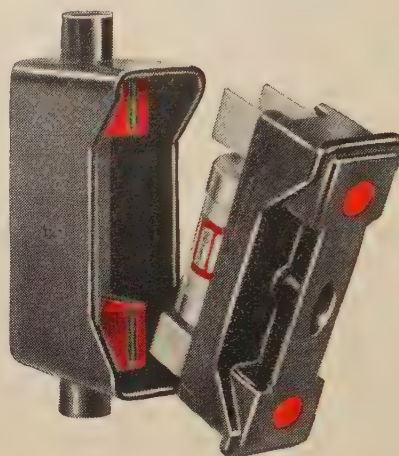
In association with: Monsanto Chemical Company, St. Louis, U.S.A. Monsanto Canada Limited, Montreal. Monsanto Chemicals (Australia) Ltd., Melbourne. Monsanto Chemicals of India Private Limited, Bombay. Representatives in the world's principal cities.

A WIDE RANGE OF ELECTRICAL DISTRIBUTION EQUIPMENT

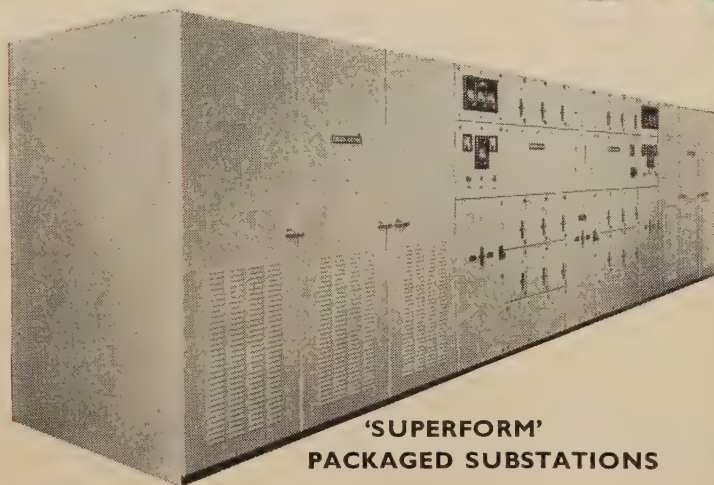
TYPE 'T' H.R.C. FUSE-LINKS
(35 MVA at 440 Volts A.C.)



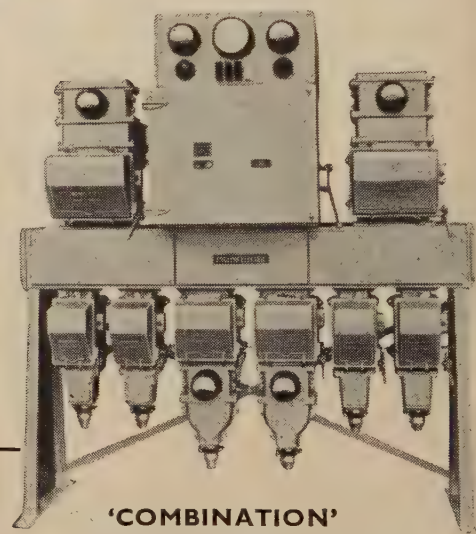
**'RED SPOT'
H.R.C.
FUSE FITTINGS**



**'RED SPOT'
HEAVY DUTY
FUSEBOARDS**



**'SUPERFORM'
PACKAGED SUBSTATIONS**



**'COMBINATION'
FUSE-SWITCHBOARDS**

'ENGLISH ELECTRIC' manufacture:

- H.R.C. CARTRIDGE FUSE-LINKS
- *'RED SPOT' H.R.C. FUSE FITTINGS
- *'RED SPOT' FUSEBOARDS
- *'SUPERFORM' SWITCHBOARDS
- *'SUPERFORM' PACKAGED SUBSTATIONS
- *'COMBINATION' FUSE SWITCHBOARDS
- *'COMBINATION' FUSE-SWITCHES
- OVERHEAD BUSBAR SYSTEMS
- OPEN TYPE SUBSTATION BOARDS ETC.

**Trade marks of 'ENGLISH ELECTRIC'*

'ENGLISH ELECTRIC'

fusegear

FUSEGEAR DIVISION, EAST LANCASHIRE ROAD, LIVERPOOL 10

The English Electric Company Limited, English Electric House, Strand, London, W.C.2

EXPANDING POST OFFICE BUSINESS

A SURPLUS of £24.3 million was earned by the Post Office in 1960-61—the last year before Post Office finances became independent. Of this £5.9 million came from the postal services and £18.4 million from the telegraph and telephone services. For the second year running there was a large expansion of business and income increased by £26.1 million to £468.6 million. Expenditure rose by £22.7 million to £444.3 million.

Capital expenditure on fixed assets amounted to £105.4 million and other capital requirements increased by £12.3 million. Of this total of £117.7 million, 68 per cent was self-financed.

The "Post Office Report and Commercial Accounts, 1960-61" (Cmd. 1521, H.M. Stationery Office, 5s 6d) warns that despite the extra £10 million of income that is expected to result this year the prospect is that profits will be well below those of 1960-61. The completion of the conversion of the inland telex system to automatic working resulted in the number of dialled calls rising by 2.6 million. The total number of calls (5.3 million) increased by 24 per cent. At the end of March the number of subscribers to the telex services was 7,089, an increase during the year of 20 per cent. Ten new automatic telex exchanges were opened. By the end of the year telex services were available to 53 Commonwealth and foreign countries.

The total number of telephone calls made was 4,300 million, 400 million more than in 1959-60.

The telephone service earned £223.4 million against an expenditure of £203.1 million, giving a surplus of £20.3 million. The main contribution to this surplus (£14.7 million) came from inland trunk calls. Trunk calls also represented the most remunerative part of the inland telephone service in terms of return on capital (12.6 per cent).

The number of exchange connections during the year exceeded 5,000,000 and by the end of the year

there were 8,280,000 telephones—more than any country in the world except the United States. A table shows that the U.K. ranks sixth in order both of telephones and of income per head of population.

The net demand for telephones reached the record figure of 503,000. The supply, at 477,000 connections, was also a record, but not enough to prevent an increase in the waiting list.

The subscriber trunk dialling system was considerably extended. Installations serving 57 exchanges, with 192,000 lines, were brought into service. Customers who have S.T.D. continue to make more calls than they did before it was introduced.

Of the expenditure on fixed assets,

amounting to £105.4 million, £87.1 million went to the telephone service, including £25 million for subscribers' circuits, £23.3 million for local lines, £19.3 million for exchange equipment and £14.4 million for trunk and junction circuits. New underground cables provided 346,000 pairs of wires for the telephone service to meet both present need and future demand. Telephone instruments, switchboards and other apparatus, and wires to the local exchanges were provided for 477,000 subscribers. Installations given up numbered 230,000.

The financial condition of the Post Office at the close of 1960-61 "despite certain immediate anxieties, was fundamentally sound . . . the Post Office would like not merely to extend but to cheapen its services. What will happen in this respect, however, must depend primarily on the movement of costs."

M.I. Group Regional Offices



The 14 new M.I. Group regional managers. Back row, left to right: Messrs. H. R. Renfree, A. S. Brain, W. J. Weston, F. D. Gough, B. G. Scott, W. H. Soper, B. L. Perkins and F. W. Whiting. Front row: Messrs. F. R. Williams, W. Jones, R. W. Puttock, W. J. A. Gemmell, S. T. Wood and E. G. Harrison

TO co-ordinate the marketing arrangements of a number of companies within the group, Metal Industries, Ltd., is establishing 14 regional offices in the United Kingdom. The new offices will each house under one roof the area sales engineers of Brookhirst Igranic, Ltd., Lancashire Dynamo & Crypto, Ltd., Lancashire Dynamo Electronic Products, Ltd., Lancashire Dynamo Nevelin, Ltd., Foster Transformers, Ltd., and, in some offices, J. G. Statler & Co., Ltd.

The following appointments as regional managers (showing region and town) have been made:—Messrs. W. H. Soper, Midlands, Birmingham; W. Jones, Mid-Southern, Bournemouth; W. J. Weston, South-Western, Bristol; F. R. Williams, South Wales, Cardiff; W. J. A. Gemmell, Scotland, Glasgow; B. L. Perkins, Eastern, Ipswich; H. R. Renfree, N.E. Yorkshire, Leeds; E. G. Harrison, Central

London, London; R. W. Puttock, S.E. London, Cheam; B. G. Scott, N.W. London, Wembley; A. S. Brain, North Western and North Wales, Manchester; F. D. Gough, Northern, Newcastle; F. W. Whiting, N.E. Midlands, Nottingham; and S. T. Wood, S.W. Yorkshire, Sheffield.

In addition, four industry specialists on an M.I. Group basis have been appointed—Mr. J. R. Morgan (steel industry, for the South, based at Cardiff); Mr. W. A. Worton (steel industry, for the North, at Sheffield); Mr. F. Nye (marine specialist, for the South, in London); and Mr. K. B. Allan (marine specialist, for the North, at Glasgow).

The appointment of three group consultants is also announced. They are Mr. H. J. Drummond (attached to the Manchester office), Mr. F. B. Rose (Newcastle office) and Mr. W. M. Hendry (Ipswich, Nottingham and N.W. London offices).

HOSPITAL LIGHTING SYMPOSIUM

A one-day symposium on hospital lighting, sponsored by the Ministry of Health and the D.S.I.R. Building Research Station, is to be held at University College, London, on 5th January. It is designed for architects and engineers both from Regional Hospital Boards and in private practice. (See Classified Advertisement Section.)

INDUSTRIAL NEWS *(continued)*

£4 $\frac{1}{2}$ Million Expansion Scheme by Firth-Vickers

A SCHEME for modernising and reorganising their facilities for the production of plates and wide sheets is announced by Firth-Vickers Stainless Steels, Ltd., Sheffield. It will cost in the region of £4.5 million and take three or four years to complete, having to be carried out in stages to avoid undue interference with production. The first stage is basically the replacement of obsolete mills by a new 80in wide hot reversing mill with fully mechanised ancillary equipment for the production of plates up to 6ft finished width and from $\frac{3}{16}$ in to 1in thickness. The mill will also be capable of rolling sheets up to 6ft wide which will subsequently be further reduced in thickness by cold rolling. Plate production, including the mill, will form a new plant to be erected at Shepcote Lane, Sheffield. Civil engineering work in preparation of the site has already commenced.

Completion of the installation of

this plant will be followed by a reorganisation of the facilities for cold rolling and final processing of wide sheets at the company's Staybrite Works, extending the handling capacity of the plant from the present 48in width to 72in.

POWER FOR ALUMINIUM SMELTING

The British Aluminium Co., Ltd., and the North of Scotland Hydro-Electric Board jointly announce that, in accordance with an agreement reached some months ago, the Board will supply the company with large blocks of power from the Highland grid when required. This means that the company will not need to install the diesel generating equipment previously contemplated. The arrangement will help the company to maintain a steadier load of operations at its Lochaber and Kinlochleven aluminium smelting works.

Ship Nuclear Propulsion not yet Economic

In the House of Commons the Minister of Transport, Mr. Marples, told Mr. Wall that the Government had been advised that, while it would be technically feasible to build a nuclear powered ship now, nuclear propulsion for marine purposes did not offer sufficient economic promise to justify building a merchant ship at the present time. The Government had therefore decided that the right course was to authorise a vigorous programme of research aimed at a reactor system which was economically attractive to a wide range of shipping. The programme would be carried out by the U.K.A.E.A. in conjunction with the industry.

Mr. Wall said that a large body of opinion felt that little further progress could be made until a prototype vessel was at sea. Would he publish a White Paper setting out the arguments for and against?

Mr. Marples said he would consider the last point. No country in the world had a nuclear reactor which was economic as far as shipping was concerned.

WATER TURBINES FOR MURRAY POWER STATION

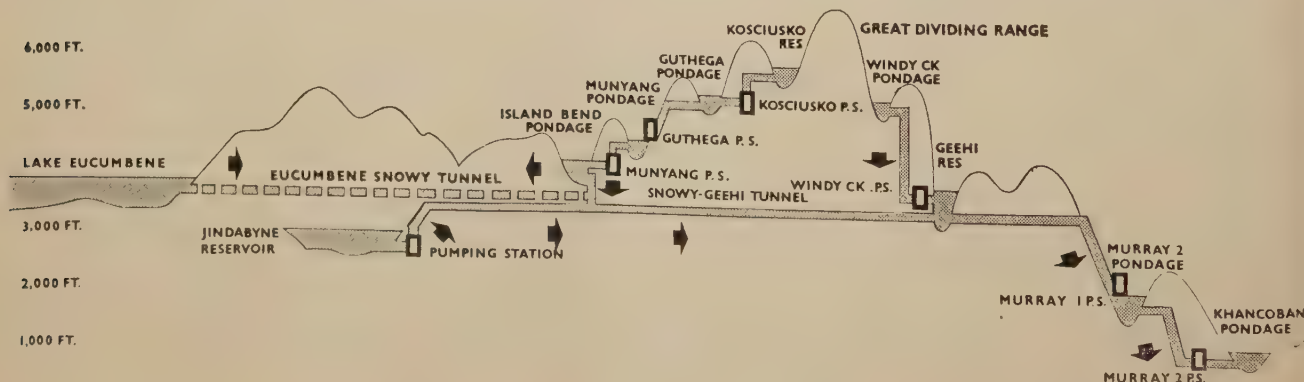
CONTRACTS were recently placed for the generating plant for the Murray I power station of the Snowy/Murray development in Australia and, through their Australian subsidiary company, Boving & Co., Ltd., have secured the order for eight 130,000 h.p. vertical Francis turbines. These units will operate under a maximum gross head of 1,719ft, among the highest in the world for large Francis turbines. The contract amounts to more than £1,500,000 in value and is one of the largest single orders for water turbines ever placed in the United Kingdom. In addition to the turbines, it includes eight 5ft 4in dia. rotary valves of special Boving design and a pressure relief valve with each turbine.

The turbines are designed to run at 500 r.p.m. The design head for best efficiency is 1,610ft, but the nominal output of 130,000 b.h.p. is to be achieved down to a net head of 1,510ft. Under the maximum gross head envisaged of 1,719ft the output will reach 160,000 b.h.p. and the generators are designed to give this output on overload.

The manufacture of the turbines will be arranged partly in Australia and partly in the United Kingdom, where Markham & Co., Ltd., of Chesterfield, will undertake the work to Boving designs.

The general scheme for the water supply, storage and diversion to the Murray area is shown in the accom-

panying diagram. It will be seen that direct supply comes from the upper catchment of the Snowy River via the Island Bend pondage, while diversion of Windy Creek and the Geehi River enters at Geehi reservoir. The storage water from Lake Eucumbene will also enter at Island Bend and the long tunnel connecting these two will carry flow in either direction, water flowing into Lake Eucumbene being stored there when the supply demand of the Murray I station is exceeded by the inflow to the Island Bend and Geehi reservoirs. The Jindabyne reservoir is to be constructed at a later stage on a lower reach of the Snowy River and water stored there will be pumped up to Island Bend.



1962 I.E.A. Exhibition

Nearly 500 firms, many of them from overseas, are taking part in the 4th International Instruments, Electronics and Automation Exhibition which is to be held at Olympia, London, from 28th May until 2nd June next. A feature of the 1962 I.E.A. will be the greater number of large stands—on an average individual stand space has increased by 20 per cent. The total area covered by the display will be more than 250,000 sq ft.

E.D.A. Public Speaking Competition

The closing date for entries for the 1962 E.D.A. Public Speaking Competition is 1st December. Competitors, who must be employed in the electricity supply industry and under 35 years of age, may speak on "Advertising with a Purpose," "The Salesman as the Consumer's Friend" or "Where Would you put the Pylons?" Should none of these appeal, a free subject may be chosen, the only stipulation being that it must have a clear connection with electricity utilisation. At the beginning of next year Electricity Boards will begin holding their area competitions, the winners going through to the national finals, which will be held in London during May.

A booklet, "Public Speaking is Great Fun" (EDA 1772/Q) is available from Electricity Boards or direct from the Association, 2, Savoy Hill, London, W.C.2. This free booklet also contains an entry form.

Kent Railway Electrification

The Parliamentary Secretary to the Ministry of Transport, Mr. Hay, said in the House of Commons that by last month all railway lines in Kent had been electrified with the exception of those from Tonbridge and Ashford to Hastings, and the Isle of Grain branch, which were not included in the scheme for electrification. Replying to Mr. J. Wells, he also said that the fencing had been brought up to the standard required by the Chief Inspecting Officer of Railways.

Mr. Popplewell asked whether, in view of the general concern about electrification as a whole, the Minister would consider preparing a graph showing the state of progress compared with the last reappraisal of the modernisation work of the railways.

Mr. Hay said he would consider the point but he doubted whether progress in electrification lent itself to graphical presentation in the way suggested.

F.H.P. MOTOR PRODUCTION

FOLLOWING close on "All In A Day's Work," the film unit of Brook Motors, Ltd., has completed another 16 mm film with the title of "Motors by the Million." This is a colour film dealing with the company's new factory which has been specially designed and built for the production of fractional horse-power motors.

It follows through the manufacturing sequences from the entry of raw materials to the dispatch of finished motors, showing to good effect the

part played by conveyor systems in streamlining handling with a minimum use of labour. A good example of this is on the stator winding line, where work is distributed to the girl operatives by entirely automatic means.

The commentary is spoken by B.B.C. television newscaster Michael Aspel and the film (running time 16 minutes) is available on free loan on application to the Publicity Department of Brook Motors, Huddersfield.



In this scene from the new Brook film "Motors by the Million" newly fitted motors are given electrical running tests before being passed for painting

TRADE ANNOUNCEMENTS

The **Electric Construction Co., Ltd.**, of Wolverhampton, the **Reliance Electric & Engineering Co. of Cleveland, Ohio, U.S.A.**, and **Schindler-Reliance Electronics, Inc.**, of Dierikon/Lucerne, Switzerland, are co-ordinating their engineering and marketing interests in the industrial electronics, engineered drives and associated fields.

The **Normand Electrical Co., Ltd.**, has appointed Mr. A. H. Scottorn, 51, Kenmore Crescent, Northville, Bristol, 7 (telephone: Bristol 693228), as sales engineer for Cornwall, Devon, Somerset, Dorset, Glos., Wilts., Bucks. (excluding Aylesbury) and Oxfordshire, and Mr. R. H. Ashbee, 88, Oundle Road, Orton Longville, Peterborough (telephone: Peterborough 2705), as sales engineer for Notts., Lincs., Leics., Northants. and Rutland.

Dawe Instruments, Ltd., have assumed responsibility for the export sales of equipment by **Cawkell Research & Electronics, Ltd.** This move is part of the reorganisation programme following the entry of both firms into the Simms Group about a year ago. The production of Cawkell equipment has already been integrated

with that of Dawe at their new factory at Western Avenue, Acton, W.3.

The "Dustmaster" built-in vacuum cleaning machine made by Sir George Godfrey & Partners (Industrial), Ltd., is now named the "Vacuumaster" and is being manufactured and marketed in the United Kingdom and Europe by the **Built-In Vacuum Cleaner Co., Ltd.**, 93, Black Lion Lane, London, W.6. The company provides an advisory service for the trade and a leaflet is available giving details of the system.

Morganite Electroheat, Ltd., have been appointed sole distributors in the United Kingdom for the Norton Crystolon hot rod, for use as electric furnace heating elements in the temperature range up to 1,575°C, and the super hot rod, a new product designed for applications up to a maximum element temperature of 1,700°C. Both products are additional to the range of Morgan "Crusilite" elements manufactured at Wandsworth.

The telephone number of **Brentford Transformers, Ltd.**, is now Crawley 27755 (8 lines).

NEW ELECTRICAL EQUIPMENT

LUMINOUS CEILING

An illuminated ceiling has been announced by ISORA ILLUMINATING CEILINGS, LTD., Bedford Avenue, Slough, Bucks., known as the "Thermalucet" ceiling. It consists of a supporting gridwork of 18 s.w.g. hot dip galvanised mild steel with V-shaped bottom flanges to all sections.

The translucent panels consist of two layers of thin p.v.c. mounted on a light m.s. frame and separated by a still air space of approximately 1 in. The p.v.c. film used is in the "self extinguishing" fire category. The panels are retained on the supporting frame by small U-shaped perimeter beading which locks the p.v.c. firmly and permanently in position and at the same time protects the translucent film from accidental abrasion at its edges. Light transmission through the double panel may be calculated, for practical purposes, by multiplying the transmission factors of the individual films. A wide range of films can be used, including coloured, printed, translucent and opaque types.

The standard module for the ceiling is 3 ft 4 in. Other modules can be supplied, however, as well as special-sized panels. The average cost of the ceiling will be about 7s 6d/sq ft, supplied and installed.

SOLID-FRAME MOTORS

A series of heavy-duty d.c. motors which are electrically and mechanically interchangeable with mill type motors to A.I.S.E. Standards ("600 Series"),

but are of solid-frame construction, has been announced by LAURENCE, SCOTT & ELECTROMOTORS, LTD., Manfield House, 376, Strand, London, W.C.2. The motors, termed "Dreadnought," are constructed to facilitate maintenance of commutator and brush gear, the latter being carried on a rocker so that, if necessary, access to all brushes can be obtained from the cover on one side of the machine only. Tensator-type brush-tensioning assemblies are used, both to give improved performance under conditions of shock and vibration and to simplify brush changing.

The new range covers the same outputs as the A.I.S.E. motors, up to about 200 h.p., and the machines are available either totally-enclosed (1 hr rated) or forced ventilated (6 hr rated) for 75°C rise.

POLYPHASE DIRECTIONAL RELAY

A relay for inverse definite minimum time (i.d.m.t.) directional protection is being made by the ENGLISH ELECTRIC CO., LTD., English Electric House, Strand, London, W.C.2. The relay is known as the type P.C.D. and is a polyphase directional relay, detecting the direction of power flow in a feeder and operating correctly under both phase and earth fault conditions. It is fitted in a double ended single-pole drawout case. For i.d.m.t. directional protection the relay serves all three phases. Thus the overcurrent and earth fault relay elements for all phases can be housed together in a single

three-pole case instead of with their individual single-phase directional units in three separate cases.

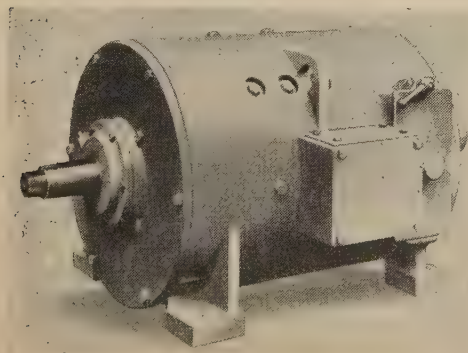
The relay is an eight-pole induction cup unit. Four current coils and four voltage coils are supplied from the line current and voltage transformers and the coil leads are brought out to the relay case terminals to allow two possible methods of connection. With one, the voltage coils are connected in quadrature and the relay develops maximum torque when the phase current lags the phase-neutral voltage by 70°. With the other, the coils are in median connection and the maximum torque angle is 40°.

The contact on the induction cup unit energises an auxiliary unit having three pairs of normally open self-reset contacts which can be electrically separate or commoned on one side.

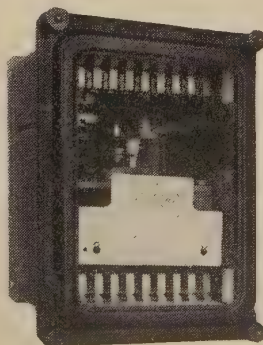
The current rating is 0.5, 1, 2 or 5 A and the current withstand is two times rated current continuously and 20 times rated current for 3 sec. The voltage rating is 110 V phase-to-phase and the voltage withstand is 110 per cent of rated voltage continuously. At rated current and voltage the maximum burdens for the current and voltage coils, respectively, are 6.5 and 7.5 VA in the red phase, 3.6 and 13.5 VA in the yellow phase, and 2.75 and 12.5 VA in the blue phase.

WIRE FEED SPEED MONITOR

In consumable electrode welding the electrode wire is fed from a spool into the weld zone and the rate of feed



Laurence, Scott "Dreadnought" solid-frame d.c. motor



English Electric polyphase directional relay



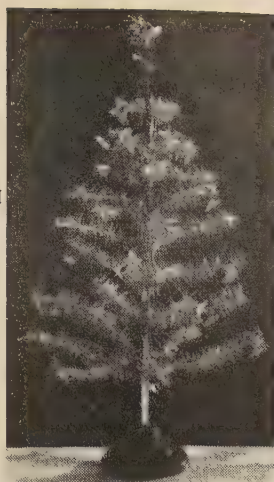
Wire feed speed monitor developed by the British Welding Research Association

has a critical influence upon the quality of the joint produced. The usual method of determining wire feed speed is by direct tachometer reference to the speed of the drive rolls but the BRITISH WELDING RESEARCH ASSOCIATION, Abington Hall, Cambridge, has developed a monitoring instrument which is independent of the feed rolls and produces a signal which is capable of reproduction either on an oscilloscope or as a direct meter reading. In this instrument, the wire drives a milled spindle on which is mounted a disc having regularly spaced slots around its periphery. The disc is positioned between a small lamp and a photoelectric cell. As the disc rotates the light beam is interrupted and the electrical resistance of the cell alternates accordingly, the cycles taking place 72 times with each revolution of the driving spindle.

The change in electrical resistance, applied to a transistorised amplifying circuit, produces a square wave output signal which is fed into an electronic frequency meter coupled to a direct reading "inches per minute" scale. The instrument is calibrated for 0-30, 0-300, and 0-600 in/min, the entire scale being used in each range which is selected by a switch. Since the value of the light energising the photo cell must remain constant, a position is provided on the selection switch for measuring the output of the 6 V battery supplying the lamp. A minimum value is indicated on the meter scale below which the accuracy of the instrument falls off, and this serves as a warning that the batteries should be replaced. The monitoring head itself measures 3in in diameter by 1in deep and will handle wire up to $\frac{1}{8}$ in diameter.

ILLUMINATED CHRISTMAS TREE

A compact Christmas tree with its lamps already fixed has been added to the range of decoration lights manufactured by PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2. It is fitted with 20 miniature lamps with transparent star-shaped backings attached to the branches, which can be arranged as



Philips illuminated Christmas tree

desired. The tree stands on a red plastic base and the overall height is 30in. It is packed in a cylindrical presentation box and the price, including purchase tax, is £2 10s 4d.

ELECTRIC FIRELIGHTER

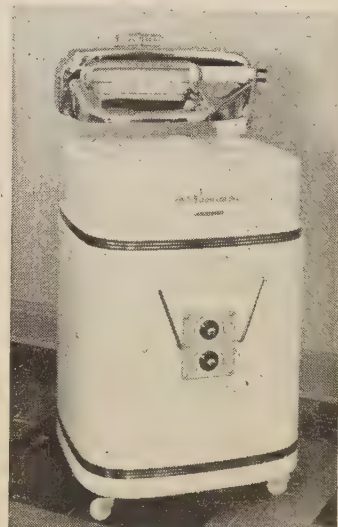
The new "Matchless" electric firelighter which has just been introduced by BEST PRODUCTS, LTD., Ranelagh House, Felixstowe, Suffolk, has a nozzle which is made from a special refractory claimed to combine resistance to high temperature with robust mechanical strength. The nozzle is said to be a permanent part of the firelighter and does not require periodic replacement. The firelighter functions by projecting a stream of air at approximately 800°C on to the fuel. The basic components are a continuously rated induction motor; a metal-bladed air impeller; and a 1,100 W heating element. The complete unit is mounted on a steel frame which enables the nozzle to be adjusted to the correct height for different grates. The body is constructed from pressed aluminium and is fitted with a two-position control switch marked "fan only" and "heater and fan." A neon lamp indicates when the lighter is in the latter position. The finish is in hammered bronze and the price, with 6ft of 3-core flexible, is £4 19s 6d, plus £1 purchase tax. The "Matchless" is said to qualify for local government grant under the Clean Air Act.

HIGH OUTPUT LAMPS

The high output fluorescent lamps made by Westinghouse are now being distributed in this country by TROUGHTON & YOUNG (LIGHTING), LTD., 143, Knightsbridge, London, S.W.1. These 8ft 110 W lamps have



Best Products "Matchless" electric firelighter



"Climax" model S.990 PTH washing machine (Warmsley Brothers (Import), Ltd.)

a light output of 9,300 lumens and an average continuous life of 18,000 hours. Other Westinghouse lighting products are also available including mercury vapour lamps. In this range, the "Hi-Output Lifeguard" lamp of 400 W rating has a mean lumen output of 20,400 and an average life of 12,000 hours.

WASHING MACHINE

The Canadian-made "Climax" washing machine, model S.960 PTH, is now being distributed in this country by WARMSLEY BROTHERS (IMPORT), LTD., 216, Southampton Way, London, S.E.5. The machine has an extra large size tub (water capacity 16½ gal) and is capable of dealing with 12 lb dry weight of clothes at a time. A special feature of the machine is a control panel which, in addition to operating the machine automatically, also controls its automatic wringer. An electrically driven pump is fitted which is claimed to empty the tub in less than two minutes. It is driven by a $\frac{1}{4}$ h.p. motor, rubber-mounted to ensure quietness in operation, and four castors fitted to the base of the machine provide for

ease of movement. The tub, the outside casing and the wringer casing are finished in white porcelain enamel.

Model S.990 PTH is additionally fitted with an automatic timer, whilst its wringer has a polished chromium top. Both models are available for the 230/250 voltage range. The respective prices, including purchase tax, are £83 3s 10d (S.960 PTH) and £88 2s 9d (S.990 PTH).

SOUND LEVEL INDICATOR

The latest transistorised sound level indicator available from DAWE INSTRUMENTS, LTD., Western Avenue, London, W.3, measures 6 by 3 by 2½ in and weighs 14 oz complete with dry batteries. The range of the type 1408D instrument is from 64 to 110 dB, and the Rochelle-salt-crystal microphone remains unaffected over the temperature range 0-45°C. The indicator has three filter networks, which give it a frequency response similar to that of the average human ear at different noise levels.

The microphone feeds a high input impedance circuit followed by a four-position attenuator and buffer stage. Its output is fed to a two-stage

amplifier with associated resistance-capacitance weighting networks, which in turn feed the meter amplifier circuit. This two-stage system has the meter and rectifiers in a negative feedback line to provide good scale linearity. Both amplifier sections are designed to have stable gains which are virtually unaffected by variations in transistor parameters or supply voltage. A printed circuit with "end mounted" components is used. Power is provided by a single 9 V dry battery. The attenuator control knob has an additional battery voltage check position.

PRINTED CIRCUIT BOARD PROTOTYPES

It is claimed that an average of 15 minutes only is required to mark out, mask and etch prototype printed circuit boards using the "Fotoceram" kit produced by ELECTROSIL, LTD., Colnbrook, Slough, Bucks. The kit comprises an etching tray, two grid boards, two bags of etching compound, a ball-point resist "pen" and a card of masking tape. The basis of the board is a copper clad ceramic formed by the heat treatment of glass. The copper plate is virtually integral and will withstand repeated soldering, up

to 50 times. Standard component mounting holes are 0.052 in nominal on 0.1 in centres and are through-copper-plated.

GENERAL PURPOSE RELAY

The type G.P.S.T. miniature wire-in or plug-in general purpose relay introduced by ERICSSON TELEPHONES, LTD., Beeston, Nottingham, can have springset combinations including four changeovers or six makes as well as arrangements using any number of contact springs up to twelve. Contact operation is controlled by a lifting card in association with an armature assembly. Relays can be supplied either voltage or current rated and with an operating time of the order of 10 msec or less in the case of relays for use in computer circuits.

The approximate overall dimensions including tags are length 1.5 in, height 1.25 in, depth 0.5 in. Dust covers may be fitted if required. The contact materials available include gold alloy, silver, palladium and platinum. The preferred operating voltages are 6, 12, 24 and 48 V, +20 per cent, -12½ per cent. Coil resistances range from 0.25 to 8,500 Ω.

CABLE JOINTING MACHINE

THE Egerton "New Way" cable jointing machine now being distributed by VINATEX, LTD., Devonshire Road, Carshalton, Surrey, is a portable, self-contained apparatus for producing permanently insulated, watertight and flexible joints in cables sheathed with p.v.c. It can also be adapted for the repair and jointing of polythene sheathed cables. Various types of joints can be made, including Y and T junctions, and also multi-cored joints such as are required in T-ing subsidiary cables through main line runs. It can also be adapted to reinforce the cable outlets of plugs and sockets, and it can produce straight-through joints of the same diameter as the cables being jointed.

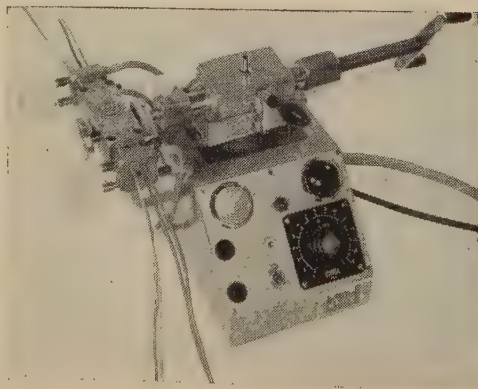
Two standard sizes of machines are available; the P1 has a capacity of 1½ in (11 mm) diameter for a straight-through joint made with butt-brazed or butt-welded conductors, and up to 2 in (9.5 mm) diameter for a bulbous joint for moulding over crimped or ferruled conductors. The capacity of the P2 is up to 2½ in (24 mm) diameter for a straight-through joint, and 3 in (22 mm) diameter for a bulbous joint. Each machine operates from an a.c. mains supply of 230-250 V.

When jointing p.v.c. sheathed cables,

the joint is placed between the two halves of a moulding jacket held together with split rings. A plastic composition — Vinagel VG133 — is forced into the jacket which is placed between thermostatically controlled platens in the machine head, where the plastic is cured at about 170°C. The attachment which must be fitted for jointing polythene sheathed cables consists basically of a barrel with a screwed plunger which is placed between the heated platens. The thermostat setting must be increased to about 200°C. Before placing the barrel in position, the plunger is removed and a solid polythene charge loaded into the

barrel. When molten, the polythene is transferred under pressure to a heated mould by the plunger.

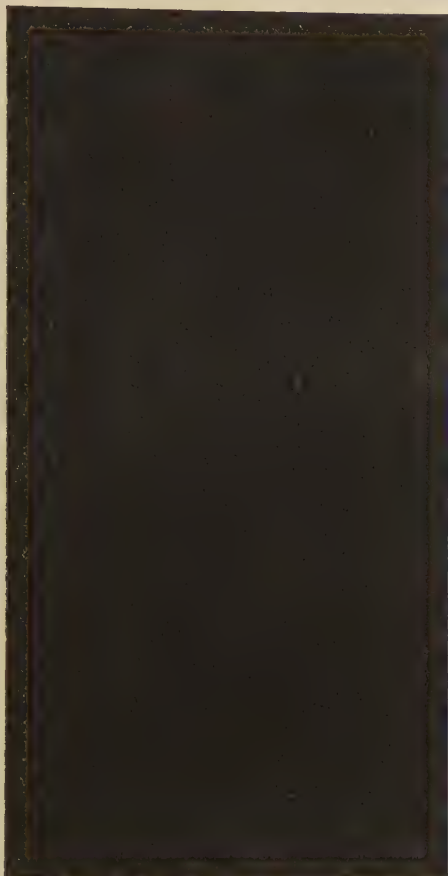
The mould, which surrounds the cable to be repaired, is fitted with heaters to ensure that the polythene insulation of the parent cable is reduced to a plastic state at the time of injection. To prevent heat flow along the cable, water cooling is introduced at the mould extremities. Cold moulds are available for joints of a temporary nature. Moulds must be manufactured to customers' requirements, and range from 1½ in (2.5 mm) to 3 in (12.5 mm) diameter, with one or more cores per mould according to size.



Egerton "New Way" cable jointing machine with attachment for polythene insulated cables. (Distributed by Vinatex, Ltd.)



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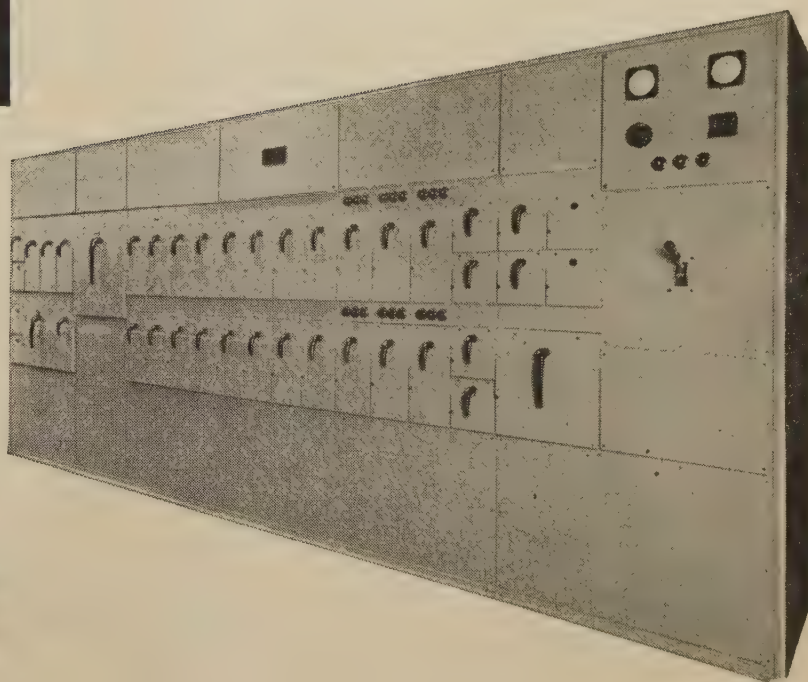
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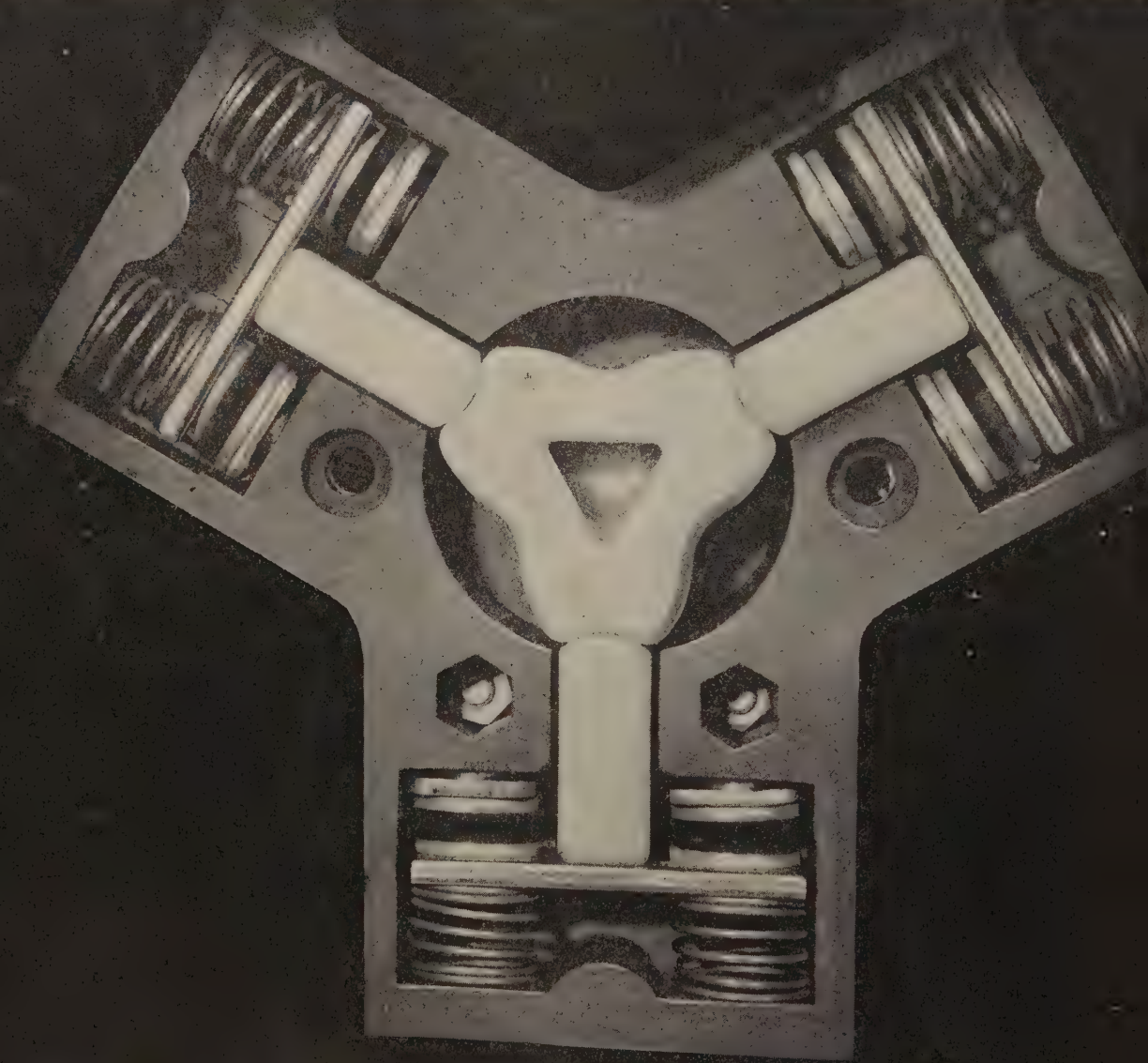


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INSTALLATION EQUIPMENT GROUP

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

"Mixed" Socket-outlets

I HAVE been reading, with great interest, your correspondence on "mixed sockets." Memories are short. Before the war the position as regards plugs in this country was chaotic. There were at least six B.S. sizes in domestic premises, in addition to a still larger number of non-standard plugs for which their makers claimed, not unfairly, certain advantages. Confronted once by Richard Dimpleby with a large bunch of about 20 assorted plugs, I blushed with shame. The late P. V. Hunter used to say that he had collected some 20 adaptors to ensure that he could use his electric razor in any part of the country. The public blamed the industry for this—and for the multiplicity of tariffs—and blamed us rightly.

During the war the various interests concerned with building were invited by the Government to review post-war development. "Post-War Building Study No. 11—Electrical Installations" was the contribution of the electrical industry. In it they said that after the widest possible review they had come to the conclusion that there was no need for more than one size of plug in domestic premises. They also pointed out that if this was a fused plug, considerable economies in wiring were possible. The B.S.I. then drew up a specification (B.S. 1363) for a 13 A fused plug and socket, and the I.E.E. set out the permissible circuit arrangements, taking account of the diversity which could be allowed by reason of ring circuits and fused plugs. The allowance of an unlimited number of sockets on one ring in a house of 1,000 sq ft or less surely satisfies the most economically-minded installation engineer. The more sockets you put in the lower the average price per socket. And all the plugs are interchangeable all over the house and, ultimately—if we are sensible—all over the country.

Post-War Building Study No. 11 also made recommendations as to the number of such sockets which should be installed—as the minimum—in domestic premises. For a 1,000 sq ft three-bedroomed house this minimum was 16. The Housing Manual, published shortly after by the Minister of Housing for the guidance of local authorities, recommended practically the same figure. There were thus two authoritative pronouncements as to the minimum number of sockets which should be installed. I regret to say that for the most part private builders and local authorities have ignored these recommendations, and that up and down the country one finds houses with one socket-outlet per room and two in the kitchen. The position does seem at last to be improving slightly but there is still a long way to go even to reach the minimum recommended figures.

Now as to costs. A single unswitched 13 A socket costs roughly 5s and a twin 13 A socket costs roughly 10s. A "mixed socket," with one 13 A and two 2 A outlets, costs 18s. All the foregoing are with boxes but without plugs. Since the ring circuit layout is clearly determined by the positions of the sockets rather than by their numbers, one can assume that the basic circuit cost is the

same in all cases. Where then is the economy of using the "mixed socket"?

Mr. Everitt's builder (*Electrical Review*, 6th October) has apparently never heard of the twin 13 A socket. He planned his house for eight single 13 A sockets, but had he planned for the use of twins he could have had 16 sockets for a total extra cost of £2 the lot. Mr. Everitt might have wanted the positions changed or wanted some extra positions, in which case some extra charge could have been expected. But there is no justification for builders to go on planning houses with eight sockets, or even fewer, and making a charge of £3 to £5 for each and every extra point which the purchaser may need.

Mr. Wilson (*Electrical Review*, 27th October) does not claim that "mixed sockets" result in economies but grumbles that the 13 A plug damages his paintwork. I have not heard this one before but it is on a par with the one I heard in a northern county, i.e. that the fused plug was a cheap device designed for municipal housing and had no place in a private residence. Mr. Wilson also makes the surprising statement that the mixed socket fully complies with I.E.E. Regulations. He should read again Regulation 114 which governs what may be connected to a ring circuit and how it should be done. There are other safety considerations, which should be borne in mind. The 13 A plug and socket was specifically designed for safety in domestic premises. It has to have shuttered contacts, it has to have a fuse of high breaking capacity (6,000 A) and it has to have its plug terminals clearly marked "red," "black," "green." Mr. Wilson might see how many of these requirements are incorporated in the 2 A part of the mixed socket. I am not saying that the mixed socket is in all circumstances unsafe or that it has not got its legitimate uses but it is clearly not what was intended or specified in Regulation 114.

So we come to the conclusion that here is a system which is not in accordance with the Wiring Regulations, is not cheaper to install, and is at variance with the avowed object of the industry, i.e. to standardise one size of plug for all domestic purposes. It is a step back to confusion. The next thing that will be offered will be a mixed socket with one 13 A, one 5 A and one 2 A outlets.

But I think good sense will prevail. The vast majority of plugs and sockets being sold today are to B.S. 1363. The public is strongly behind a standard plug and so is the industry.

Earley, Reading, Berks.

FORBES JACKSON.

Too Small?

MAY I beg the favour of your columns concerning the plight of the ordinary consumer who tries to buy domestic electrical apparatus with some discrimination?

I recently ordered two plug-and-socket flex connectors from a London manufacturer via my local retailer. Despite the fact that these were advertised in your journal, they were unknown to the retailer and not, apparently, available from the wholesalers. I was astounded to be

informed (a fortnight later) that the manufacturers concerned had refused the order because, in their own words, "it was not economic."

It is deplorable and against the interests of both the public and the electrical trade that such a farcical situation should be tolerated.

Birmingham, 14.

A. JENKINS.

Fusing L.V. Supply Circuits

IN your issue of 3rd November Mr. H. V. J. Harris was quite right in advocating the use of double-pole protection for apparatus supplied from the secondary of a step-down transformer having the centre point of this winding permanently earthed. We have got so used to fusing only the

phase wire of a.c. mains circuits that the necessity for double-pole protection in special cases such as this may be overlooked. It should be realised, however, that in the incident described by Mr. Harris, the provision of a second fuse would not necessarily have prevented the fire. A high-resistance fault might limit the current to a value less than that at which the fuse would blow, and still cause a fire. I would advocate the use of a double-pole miniature circuit-breaker; excess current in either pole will cause the breaker to trip, completely isolating any apparatus or wiring connected to it.

Pontypool, Mon.

B. C. ROBINSON,
Senior Electrical Engineer,
British Nylon Spinners, Ltd.

New Books

Guide to Broadcasting Stations. Compiled by *Wireless World*. Thirteenth Edition. Pp. 100. Published by Iliffe Books, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 3s 6d.

Many hundreds of additions and amendments have been made in preparing the material for the 13th edition of this guide. All European long- and medium-wave broadcasting stations and over 2,000 short-wave stations of the world are listed both geographically and in order of frequency. The number of television and v.h.f. sound broadcasting stations in Europe has increased tremendously: there are now over 1,600 and 1,300 respectively. The majority of them are, however, of very low power and in this edition only those with a power of 5 kW or more are included; even so, over 750 are listed. Other features include standard time throughout the world, international allocation of call signs and a wavelength-frequency conversion table.

Profit and Personality in Retailing. By Leonard M. Harris and Ulric M. Spencer. Pp. 193 and bibliography. Business Publications, Ltd., and B. T. Batsford, Ltd., 4, Fitzhardinge Street, Portman Square, London, W.1. Price 35s.

It would be difficult to disagree with the authors' description of retailing as "the most Victorian trade in Britain." Though in recent years there have been important innovations in the running of the major department stores, and completely new methods have been demonstrated in the supermarkets, a more scientific approach has not yet been induced among retailers generally. Competition is clearly not as fierce as is often claimed and retailing is thus able to remain one of the bastions of British amateurism.

The literature on retailing in this country is surprisingly small and such books as there are are mainly economic analyses. The value of the present study is that it gives practical guidance on the many factors that must be considered if a shop is to provide an efficient service and earn a satisfactory profit. The book is intelligently written and easy to read and it should encourage retailers to think constructively about their problems. To this end the introductory chapters in which the function of the retailer and his relationship with both his suppliers and his customers are discussed are of particular interest, and as the title suggests much attention is rightly given

to the importance of personal relationships. There are also clear explanations of the arithmetic of gross margin and unit cost accountancy.

The authors single out the department store for detailed comment "as being the furthest along the road to the ultimate form of retailing." The reason being that "it can provide a much greater depth and continuity of stock as well as a wide range of services." Nevertheless, most of what they have to say has a wider application since all retailers should be concerned with the over-riding importance of profit. The authors show how profits can be increased by a combination of skill and personality to the benefit of both retailer and customers.—R.F.M.

Fractional Horsepower Motors. By Kennard C. Graham. Pp. 256; figs. Technical Press, Ltd., 112, Westbourne Grove, London, W.2. Price 42s.

The typical American approach to the presentation of technical matter to lay readers is used in this book, which is intended primarily for domestic equipment repair men and servicing agents. A large number of explanatory diagrams are used to illustrate the basic theory of both a.c. and d.c. motors and the techniques employed for testing them and fault diagnosis.—T.R.W.

BOOKS RECEIVED

A Power Policy for Britain. By K. L. Stretch. Pp. 128; figs. Ernest Benn, Ltd., Bouverie House, Fleet Street, London, E.C.4. Price 18s 6d.

The Meaning of Engineering. By W. T. O'Dea. Pp. 184; figs. Museum Press, Ltd., 26, Old Brompton Road, London, S.W.7. Price 21s.

Radio for Examinations. By H. I. F. Peel. Pp. 364; figs. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 55s.

C.I.G.R.E. Conference

Next year's Conférence Internationale des Grands Réseaux Electriques is to be held from 16th to 26th May at the Fondation Berthelot, Paris. The final programme of the Conference has now been fixed; apart from the opening and closing ceremonies there will be 24 technical sessions and the usual complement of technical visits and social functions.



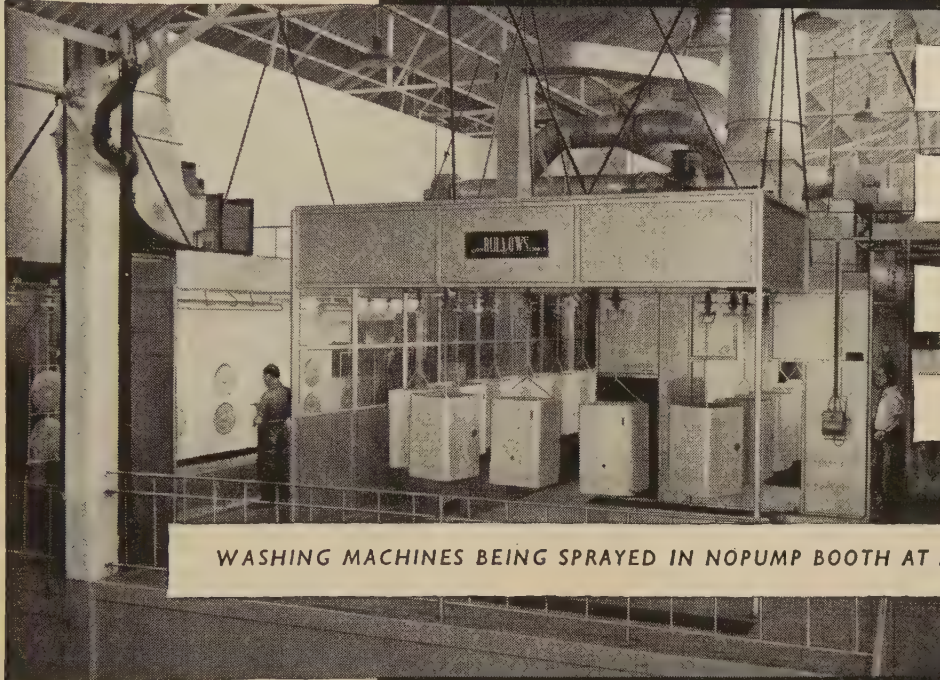
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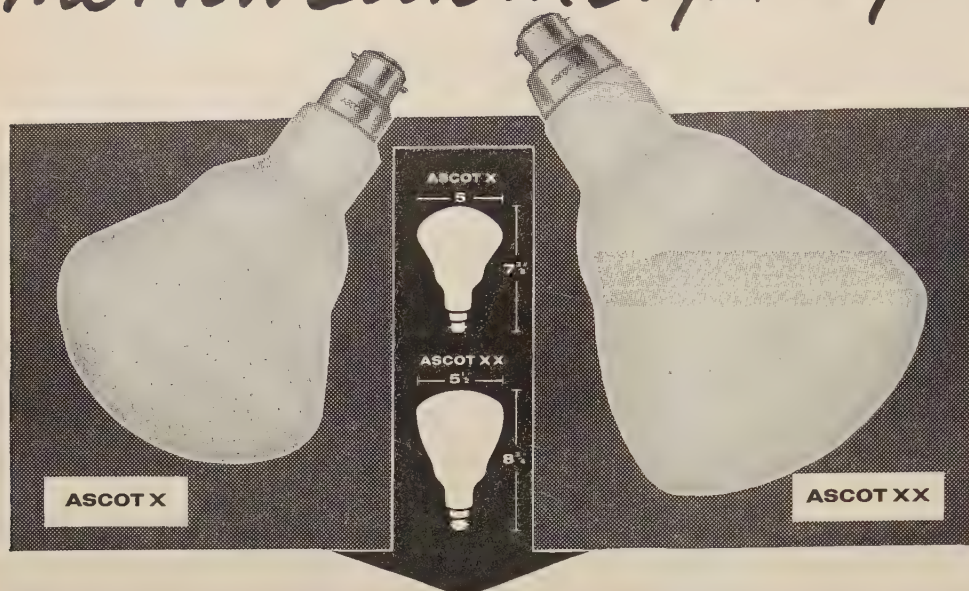
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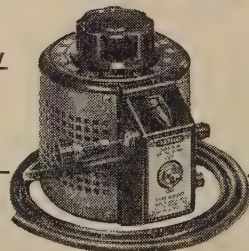
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BETTER INSTALLATIONS

Progress of the National Inspection Council

NATURALLY the rate of enrolment of firms and individuals by the National Inspection Council for Electrical Installation Contracting has slowed down since the initial influx but steady progress is being maintained. At the end of last month there were 3,847 on the Roll of Approved Contractors, a net increase of 125 in the past 12 months. Over 4,000 inspections were made, 573 of which were of installations by applicants for enrolment.

The annual meeting of the N.I.C. was held last Friday, Mr. S. E. Goodall, chairman, presiding, and afterwards there was an open discussion in which many interesting subjects were raised. In the course of this it was stated that now all the Electricity Boards were allocating their sub-contracting work to approved contractors and the number of local authorities doing the same was also increasing satisfactorily. Most of the larger firms had been enrolled and now success was being achieved among the smaller ones.

The difficulty of obtaining fuses of lower rating than 13 A for the standard fused plug was mentioned; it was thought that retailers of appliances might recommend their use and also provide them. Another view was that the 13 A fuse was so reliable that the use of smaller ones was not essential. The use of standard fused plugs in rural workshops and the employment of low voltage for portable tools were among other points raised.

At a subsequent luncheon, with Mr. Goodall again in the chair, the principal guest was Sir Robertson King, chairman of the Electricity Council and a past-chairman of the N.I.C. His was the only speech and in it he paid a tribute to Messrs. E. A. Mills and Forbes Jackson for their work in the initial stages of the scheme. In the early days financial stringency prevented extensive publicity but there had now been an improvement.

Sir Robertson uttered a warning against the dangers lurking in old installations and thought that although the Electricity Boards were reluctant to do anything about them they might in due course be forced to take some action. Similarly, greater attention had to be paid by the Boards to the earthing of domestic installations or the Government might eventually intervene. In too many installations the earth pins of plugs were "dormant and dead." Sir Robertson concluded by commending the work of the chief executive officer, Brigadier W. G. S. Thompson, and Messrs. E. J. Sutton and P. G. Wallis, the technical officers.

The proceedings ended with Mr. Goodall thanking Sir Robertson King and expressing his appreciation of the presence of so many distinguished representatives of bodies interested in the Council's work.

Report for 1960-61

In its report for the year ended 31st March last the Board states that there has been a considerable increase in the number of local authorities placing electrical installation work with firms on the Roll of Approved Contractors. The demand for the 20,000 copies of the fourth edition of the Roll exhausted the supply early in 1961 and preparations

were made for the issue of the fifth edition (22,000 copies) to all interested parties.

During the year 331 applications for enrolment were received (259 in 1959-60); 227 (against 254) were approved and 30 (38) rejected. A total of 3,805 inspections (against 3,989) were made. At the close of the year there were 3,745 firms and individuals on the Roll, a net increase of 51, with 5,467 addresses.

A total expenditure of £55,795 was met by contributions from the Electricity Council and the Electricity Boards and from enrolment fees and subscriptions and sales of publicity material.

Mr. S. E. Goodall, director of engineering, A.E.I. (Woolwich), Ltd., was elected chairman for 1961-62 and Mr. J. D. D. Shaw, managing director, James Kilpatrick & Son, Ltd., deputy chairman.

Progress Report

In its report for the quarter ended 30th September last the Board expresses disappointment with the draft regulations for electrical installations made by the Secretary of State for Scotland under the Building (Scotland) Act, 1959.

During the quarter 83 applications for enrolment were approved and 77 new applications were received. Mainly because they went out of the contracting business 34 firms were removed from the Roll.

Reference is made to the increasing interest shown in the Inspection Council's activities by the Electricity Consultative Councils and local authorities.

On the technical side, it is reported that 8,503 installations were inspected in the year to September last and it was found that in 248 cases installations were ineffectually earthed and that 157 were connected to inoperative earth-leakage circuit-breakers, but less than 20 per cent of the total installations inspected were connected to e.l.c.b.'s. It is remarked, with satisfaction, that there are indications that contractors are applying more effective tests to earthing and protective equipment.

The report calls attention to the possibility of the overheating of wiring and fittings from the use of the small bulb, compact, lamps now available. This may cause damage to wiring and even disintegration of moulded lamp-holders.

Humidity Instruments

A 16-page leaflet (List 70/1) issued by the Cambridge Instrument Co., Ltd., 13, Grosvenor Place, London, S.W.1, describes their range of hygroscopic and wet and dry bulb humidity indicators, recorders, and controllers. The leaflet begins with an introduction to the measurement of relative humidity and describes and illustrates the two common methods. The instruments described include a hygroscopic indicator for measuring the moisture content of paper and similar materials, mechanical and electrical wet and dry bulb recorders, combined temperature and humidity recorders and various types of controllers including a multi-point electronic recorder/controller.

The publication also provides general information on several humidity control systems and contains a short bibliography relating to other sources of information on the measurement and control of humidity.

Financial Section

STOCKS and SHARES

MOST of the motor-car and accessories manufacturers make up their accounts in midsummer and present the results at this time of the year. On this occasion figures substantially below the 1959-60 level are being taken for granted. Nevertheless, those published so far have been at least no worse than had been apprehended, and share prices have tended to go up after the announcements. Of the makers of cars, B.M.C. returned profits only half those of 1960-61, but the shares subsequently recovered quite strongly to 15s 6d. In the accessories field, J. Lucas shares rose by as much as 5s 6d to 56s 3d on relief that the decline in profits had extended to less than 12 per cent; and although the earnings of S. Smith & Son suffered a much larger setback, the shares were marked by a shilling to 15s 9d after the figures were known.

Motor Accessories

Neither J. Lucas nor S. Smith & Son have any difficulty in maintaining dividends at last year's rates. Distributions totalling 13½ and 20 per cent appear from the preliminary figures to be covered respectively 2½ times and twice over at the reduced level of earnings, and the yield on both companies' shares is now in the neighbourhood of 5 per cent. In the case of S. Smith the fall in profits amounted to more than one-third, having been aggravated by the effects of unofficial strikes. The latter were a factor too in Pressed Steel's decision to pass this year's interim dividend and in their warning that the year's results are likely to be most disappointing: this company's shares fell sharply to 15s 9d but recovered later to 17s 6d.

Rise in Prices

Industrial markets of the Stock Exchange have been looking a good deal more confident at times lately. In the electrical sections the recovery in shares of the major groups developed momentum, A.E.I. advancing by as much as 3s 3d during the week to 34s, while English Electric and G.E.C. each rose further by about half-a-crown. The rise in Crompton Parkinson continued up to 13s 3d and Parsons and Reyrolle were respectively 3s 9d and 4s 3d to the good. British

Electronic Industries at 10s 9d and E.M.I. at 40s reacted strongly to encouraging statements by Mr. C. O. Stanley and Sir Joseph Lockwood in their respective annual reviews. Other material improvements included those in Decca, Plessey, W. H. Sanders,

Tube Investments, Arcoelectric and Sangamo Weston.

Increased Earnings

Crabtree Electrical Industries report an increase of 10 per cent in trading profits for 1960-61, and of 25 per cent

Price Changes in

Company or Board	Nom. Value	Middle price 13th Nov.	Week's Rise or Fall	Dividend		Yield %	1961		
				Pre-vios	Last		High-est	Low-est	
Gilt-edged Stocks							£	s	d
Brit. Elec. 1968/73	100	75½		3	3	3 19 6	75½	70½	
Brit. Elec. 1974/77	100	70		3	3	4 5 9	70½	64½	
Brit. Elec. 1976/79	100	71		3½	3½	4 18 6	73½	67	
Brit. Elec. 1974/79	100	80		4½	4½	5 6 3	82	75	
Brit. Elec. 1967/69	100	92		4½	4½	4 17 9	92	86	
Overseas Electric Supply									
Calcutta Elec.	£1	21/3		7†	7½†	11 11 0	22/3	20/6	
East African Power	£1	13/-		8	10	15 7 9	15/-	13/-	
Nigerian Elec.	£1	19/-		10	14	14 14 9	19/9	15/6	
Perak Hydro-Elec.	£1	20/6		15	15	14 12 9	23/6	17/6	
Electrical Shares									
Aberdare Holdings	5/-	17/3		17½	17½	—	17/3	14/3	
Aerialite	1/-	4/6	+3d	54	40	8 18 0	8/-	4/3	
Allen, W. H.	£1	25/-		14	10*	8 0 0	42/6	25/-	
Allied Insulators	5/-	8/3		20	10*	6 1 3	10/-	8/-	
Alwyn Holdings	5/-	21/9	+1/3	12½	15*	3 9 0	22/3	16/6	
Anglo-Portuguese Tel.	£1	20/-		9	9	9 0 0	25/-	18/9	
Arcoelectric	1/-	5/3	+9d	15	15	2 17 3	6/-	3/9	
Astaron Electronics	5/-	23/6	+1/-	15	15	—	30/-	17/-	
Assoc. Elec. Ind.	£1	34/-	+3/3	15	15	8 16 6	48/6	28/9	
Babcock & Wilcox	£1	21/9		9	9	—	36/6	19/-	
Bakelite	10/-	45/3	-1/-	17½	17½*	3 17 3	60/-	42/-	
Baldwin, H. J.	2/-	1/-		10	Nil	—	1/9	1/-	
Berry's Electric	5/-	60/-	+2/6	30	33½*	2 15 9	60/-	37/-	
Bowthorpe Holdings	2/-	7/6	-3d	18½	22	5 17 6	10/3	7/6	
Brit. Elec. Resistance	2/-	7/-		17½	17½*	5 0 0	8/9	6/6	
Brit. Elec. Traction:									
Def. Ord. "A"	5/-	52/6	+2/-	40	50	4 15 3	57/6	41/9	
British Electronic Ind.	5/-	10/9	+6d	—	15	6 19 6	15/3	8/9	
B.I. Callender's	£1	58/3	+1/3	13½	13½	4 12 9	62/3	49/6	
B.I. Callender's 6% Pref.	£1	17/-		6	6	7 1 3	18/3	16/6	
British Thermostat	5/-	31/9	+6d	20	27½	4 6 9	40/-	28/-	
Brook Motors	10/-	50/6		25	25*	4 19 0	55/-	47/-	
Bruce Peebles	10/-	16/-		10	Nil	—	21/-	13/3	
Bulgin, A. F.	1/-	12/3		55	40*	3 5 3	13/3	7/9	
Bulpitts	5/-	16/-		15	16½	5 1 6	27/6	16/-	
Burco Dean	5/-	6/6		18	15	11 11 0	11/9	6/3	
Cable & Wireless	5/-	17/-	-1/-	10	10*†	2 18 9	19/9	12/6	
Cambridge Instruments	5/-	31/-		12½†	22	3 11 0	38/6	30/-	
Chloride El. Storage "A"	£1	72/6		17½	20	5 10 3	91/-	72/-	
Clarke Chapman	£1	39/-	-1/-	13½	13½	7 1 0	54/-	37/6	
Clarke, T.	2/-	4/-		16	16	5 6 9*	5/3	3/6	
Combined Elec. Mfrs.	4/-	7/-		—	12½	7 2 9	10/-	6/9	
Contacto Switchgear	5/-	14/3		14	14	4 18 3	16/-	12/6	
Crabtree	10/-	24/9	+1/9	12½	12½	5 1 0	33/9	23/-	
Crompton Parkinson	5/-	13/3	+6d	12½	12½	4 14 3	14/6	11/3	
De La Rue	10/-	49/6	+3/-	22½	22½*	4 11 0	70/-	44/6	
Decca "A"	10/-	62/6	+3/-	23½	23½	3 14 6	70/-	52/3	
Desoutter	5/-	55/-		30	35	3 3 9	68/9	49/-	
Dewhurst	2/-	5/6	+3d	20	20	3 12 9*	6/6	3/9	
Dictograph Tel.	2/-	10/9		20	20	3 14 6	13/-	8/6	
Dimplex	5/-	55/-	-6d	30	35*	1 18 3*	55/6	28/3	
Dubilier Condenser	1/-	2/3	+3d	30	15*	6 13 3	3/-	2/-	
Duport	5/-	10/9	+3d	17½	20	6 4 0*	17/-	10/3	
E.M.I.	10/-	40/-	+4/3	17½	17½	4 7 6	51/3	35/3	
Eleco	2/-	10/3	+1/-	20	20*†	3 18 0	10/6	4/3	
Electrical Apparatus	5/-	20/-		20	22	5 10 0	21/-	17/-	
Electrical Components	5/-	8/6		11½	12½	7 7 0	9/9	7/9	
Elec. Construction	£1	20/3	-6d	9	5	4 18 9	39/-	20/-	
Elliott-Automation	5/-	35/9	+1/-	9.3	13	1 16 3	37/6	25/6	
Enfield Rolling Mills	£1	36/-	-2/6	15	15	8 6 9	51/6	36/-	

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend indicated.

in the net surplus remaining after a proportionately smaller tax charge. These results were well up to market expectations, and although the dividend is being restricted to the previous total of 12½ per cent the 10s shares moved up to 24s 9d, bringing the yield to

just over 5 per cent. Alwyn Holdings have declared the 15 per cent dividend forecast at the time of a scrip issue in June. It compares with the previous equivalent of 8½ per cent and is in accordance with the directors' forecast of a more liberal distribution policy

following the reduction of outstanding liabilities. Even so, the new rate still has more than fourfold cover.

B.I.C.C. Margins

A statement from British Insulated Callender's Cables on results for the first half of the current year showed trading profits to have improved, in comparison with the first six months of 1960, by 18 per cent to £3.3 million, while sales expanded by little more than 1 per cent to £75 million. The statement emphasised that this 4.4 per cent margin of profit on turnover still left very little to spare, but the evidence of a material improvement upon last year's rate of 4 per cent was welcomed in the market, where the £1 shares were advanced further to 58s 3d. The interim dividend is being maintained at 4 per cent on larger capital and shareholders are told that the improvement experienced in the first half of the year should be at least maintained.

Racal Electronics

There was a spectacular beginning last week to dealings in the 5s shares of Racal Electronics. "Placed" at 20s 3d, the shares opened at 28s 6d and went rapidly ahead to 33s 6d. Formed as recently as 1950, this firm of specialists in radiocommunication and electronic equipment is shown in the prospectus to have established already a remarkable rate of expansion. Earnings have more than quadrupled in the past five years, reaching £182,000 in the period ended last January. They are expected by the directors to be at least maintained at that level in 1961, and in this event it is their intention to pay dividends totalling 17½ per cent. Such a rate would be covered 2½ times over by the profits estimate and would produce a yield of under 2½ per cent on the shares at 33s 6d. Production has recently been increased and further growth is confidently anticipated.

Sun Electrical's Progress

Dividends of the Sun Electrical Co. are being maintained at the total of 18½ per cent to which they were raised a year ago. Figures in the preliminary profits statement for the year ended in April gave an impression that a more liberal payment might well have been recommended in the absence of the Chancellor's appeal for restraint, for the latest improvement of 20 per cent in earnings to £181,000 (before tax) follows one of 50 per cent in the preceding twelve months, and gives a net surplus more than 3½ times the amount distributed in dividends. Following the announcements the price of the 5s shares was marked up to 16s.

Electrical Investments

Company or Board	Nom. Value	Middle price 13th Nov.	Week's Rise or Fall	Dividend		Yield %	1961		
				Pre- vious	Last		High- est	Low- est	
Electrical Shares—continued							£	s	d
English Electric ...	£1	31/3	+2/9	10	10	6 8 0	40/9	26/3	
English Electric 3½% Pref. ...	£1	10/9	+3d	3½	3½	7 0 0	11/9	9/9	
Ever Ready ...	5/-	38/6	+6d	20	22½	2 18 6	40/-	31/6	
Falk Stadelmann ...	£1	23/-		7½	8½	7 12 3	26/-	21/9	
G.E.C. ...	£1	28/9	+2/6	10	10	6 19 3	39/6	24/3	
G.E.C. 6½% Pref. ...	£1	16/6		6½	6½	7 17 6	19/3	16/6	
General Cables ...	5/-	4/9		15	Nil	—	6/3	4/9	
G.H.P. Group ...	£1	19/-		6	7½	7 7 3	24/6	17/-	
Goblin (B.V.C.) ...	5/-	4/6		12½	10	11 2 0	8/6	4/3	
Hackbridge Holdings ...	5/-	5/6		20	10*	9 1 9	6/9	5/-	
Harland Engineering ...	5/-	12/6		16	16	6 8 0	19/-	12/-	
Head Wrightson ...	5/-	20/-		14	16	4 0 0	30/-	20/-	
Heatrae ...	2/-	16/9		12½	25	2 19 9	19/-	12/6	
Holophane ...	5/-	16/9		30	30	8 19 0	20/6	14/6	
Hoover ...	5/-	49/6		90	45*	4 11 0	55/6	37/6	
Hunt, A. H. ...	4/-	17/9		20	20	4 10 3	25/9	17/6	
Intl. Combustion ...	5/-	23/9		20	30	6 6 3	33/9	22/9	
Intl. Computers & T. ...	£1	93/9	+3/9	10	11½	2 8 0	107/-	59/-	
Johnson & Phillips ...	£1	21/3	+1/3	Nil	5	4 14 0	24/-	17/6	
Kenwood Mfg. ...	1/-	3/3		—	—	—	6/-	3/3	
Laurence Scott ...	5/-	15/-	+3d	15	15	5 0 0	18/9	14/3	
Lister, R. A. ...	£1	55/-	+3/-	14	14	5 1 9	56/9	45/6	
Lucas, J. ...	£1	56/3	+5/6	13½	13½	4 17 9	71/6	50/-	
Marryat & Scott ...	2/-	16/9		27½	32½	3 17 6	18/6	13/9	
Mather & Platt ...	£1	36/9		11	11	5 19 6	51/6	36/-	
Metal Industries ...	£1	50/-	+1/3	15	15	6 0 0	66/6	46/3	
Midland Elec. Mfg. ...	£1	52/6		12	12	4 11 6	67/6	52/6	
Murex ...	£1	39/6	+6d	20	13*	6 11 3	51/6	37/6	
Newman Ind. ...	2/-	7/-		12½	15	4 5 9	7/6	5/-	
Oldham & Son ...	1/-	2/6		17½	17½*	7 0 0	3/-	2/3	
Parmiter, Hope & S. ...	1/-	2/-		12½	20	10 0 0	2/5	1/6	
Parsons, C. A. ...	£1	52/6	+3/9	9½	12½	4 15 3	72/6	46/9	
Philips' Lamps ...	£1.10	220/-		16	16*	1 9 0	£13½	£9½	
Plessey ...	10/-	42/6	+1/6	17	15*½	3 10 6	45/-	35/3	
Pullin Group ...	2/-	10/6		25	25	4 15 3	15/-	10/-	
Pyrotex ...	5/-	42/-		40	45	4 0 0*	48/9	34/9	
Radiation ...	£1	22/6		12	10	8 17 9	37/6	22/6	
Reliance-Clifton ...	5/-	18/3		15	20	3 13 0*	22/-	14/9	
Reynolds ...	£1	42/6	+4/3	17½	9½*	4 11 9	51/6	36/6	
Richardsons Westgarth ...	10/-	3/6	-6d	8½	Nil	—	8/3	3/6	
Sanders, W. H. ...	2/-	17/6	+1/-	17½	17½½	2 0 0	28/3	14/-	
Sangamo Weston ...	10/-	25/6	+4/3	13½	10½*	3 18 6	25/9	18/9	
Scott, James ...	5/-	29/-	-6d	25	27½	4 14 9	32/-	25/6	
Simon Engineering ...	5/-	32/9	-9d	—	27½	4 4 0	43/9	28/-	
Smith (England), S. ...	4/-	15/9	+1/-	20	20	5 1 6	23/9	13/9	
Southern Areas ...	£1	17/-		5	6	7 1 3	23/-	14/6	
Strand Elec. ...	5/-	16/3		14.6	20	6 3 0	20/-	12/3	
Sturtevant ...	5/-	9/3	-6d	15½	13½	10 18 0	18/6	9/-	
Sun Elec. ...	5/-	16/-	+1/9	18½	18½	5 15 3	17/6	14/3	
T.C.C. ...	10/-	40/-		35	22½	5 12 6	43/9	40/-	
Telephone Rentals ...	5/-	26/-		15	15½*	2 17 3	29/6	18/6	
Thompson (John) ...	5/-	12/9		20	5	—	16/9	12/9	
Thorn Elec. ...	5/-	56/6	-6d	25	25	2 4 3	63/-	44/6	
Thornycroft ...	4/-	4/3	-1/-	6	—	—	7/-	4/3	
Tube Investments...	£1	67/6	+3/6	—	14	4 2 9	85/-	54/-	
Ultra Electric ...	5/-	19/6	+9d	20	25	—	31/3	12/6	
Walsall Conduits ...	4/-	10/6	+3d	15	15	5 14 3	15/-	9/9	
Ward & Goldstone ...	5/-	26/-	-6d	35	17½*	3 7 3	36/6	25/6	
Watford ...	2/-	6/9		25	20*	5 18 6	10/9	6/6	
Westinghouse ...	£1	26/-	+3d	11	11	8 9 0	45/-	24/6	
West, Allen ...	5/-	10/-	-3d	12½	13½	6 15 0	14/6	10/-	
Wilkins & Mitchell ...	5/-	8/3		21	12	7 5 6	15/3	8/3	
Wolf Electric ...	5/-	12/6	-3d	12½	13½	5 10 0	17/6	12/6	

REPORTS and DIVIDENDS

British Insulated Callender's Cables, Ltd.—The group net trading profit for the first half of 1961 was £3,321,000. This is 18 per cent more than in the first six months of 1960 and 17 per cent more than in the second half of that year. The interim dividend is maintained at 4 per cent on increased capital.

Group sales for the half-year totalled £75 million, compared with £69 million for the second half of 1960 and with £74 million for the first half of that year. There was a higher level of exports and overseas turnover.

The net trading profit is before investment income, exceptional items and tax. Trading profit shows a margin of 4.4 per cent on turnover, compared with 4 per cent for all of 1960. These returns, Sir William MacFadzean, chairman, says, "reflect the improvement in trading conditions and efficiency, but emphasise the narrowness of the margins on which we are working and the vital necessity of containing costs. On the basis of current figures the indications are that the improvement achieved in the first six months should be at least maintained during the second half-year."

Sir William adds that due mainly to the credit squeeze in Australia the profits earned by the substantial investment there have fallen a little from the record earnings in 1960 and the Canadian company has incurred a loss, productive capacity in that country under existing conditions being considerably in excess of demand. Prospects, however, look a little brighter.

E.M.I.'s Swiss Loan.—Electric & Musical Industries, Ltd., this week floated a loan of 40 million Swiss francs (£3.3 million) in 4½ per cent unsecured bonds 1966-76. In a letter to the three Swiss banks who are underwriting the loan, Sir Joseph Lockwood, chairman of E.M.I., says that the sales of the group this year are so far satisfactory and there is reason to believe that they may show an increase over those of the previous year. It is too early to make any forecast of profits but he expects them to be higher.

In his annual review, Sir Joseph says that group sales may well reach a total of the order of £90 million in the year to June, 1962, assuming no political crises. Total group sales rose by 20 per cent to £82.44 million in the year ended 30th June, 1961. If the sales of Morphy-Richards, Ltd., and Ardente, Ltd., are included for both years, total group sales rose by 2 per cent. While sales of records

rose by 8 per cent and those of electronic capital goods by 13 per cent, sales of household appliances and radio and television sets were down by 11 per cent.

Of the total sales the U.K. was responsible for £35.5 million, other European countries £13.2 million, the Western Hemisphere £22 million and the rest of the world for £11.7 million.

Sir Joseph says that the new powers for making small variations in the rates of purchase tax are preferable to the kind of changes in the past in hire-purchase regulations, but he would like to see the incidence of the tax widened so that the rates could be lowered and made uniform for all trades.

He adds that the market for household appliances has not yet purged itself completely of all surplus stocks of refrigerators, washers and other goods and a cautious view must be taken of prospects in the present financial year. Looking further ahead, however, Sir Joseph believes "we are entitled to be less cautious and more confident and optimistic about prospects." With the Astral refrigerators, the company increased its share of the home market and of exports and by the end of the financial year had cleared its stocks.

Closed circuit television, says Sir Joseph, is an expanding market in which the group is increasing its share. More research and experiment will be necessary before a method of colour transmission can be decided upon which will stand the test of time, as the present black and white system has done. It seems likely, he adds, that wired TV will be essential in many areas for colour programmes.

Whether or not Britain joins the Common Market, the group is well placed, with companies in both areas. The directors are assessing the likely course of developments, in particular the implications for the organisation of E.M.I. manufacture and development in the Common Market and Free Trade Area.

Strand Electric Holdings, Ltd.—In his annual statement, the chairman, Mr. J. D. H. Sheridan, reports a most successful financial year, and the prospect continues bright, he says, for the current and future financial years. He cannot, at present, see any reason why 1962 should not be at least as good as 1961.

Rediffusion, Ltd.—A tax-free interim dividend of 9 per cent (same) is being paid on a larger capital. The directors expect to pay a 5 per cent tax-free final dividend on the capital as in-

creased by the two-for-one scrip issue announced last week, making a total distribution equivalent to 24 per cent tax free.

The Plessey Co., Ltd.—Trading profits for the year ended 30th June dropped from £4,227,597 to £3,422,659. This figure is partly based on estimates and includes adjustment of profits of previous years, directors' emoluments and £948,203 for depreciation. With other income the total profit is £4,049,794 (£4,300,884), and the profit after tax amounts to £1,712,886 (£1,907,850). The adjustment of profits of previous years arises primarily from price settlements on long term contracts, which, although less than last year, was still somewhat higher than might normally be expected.

Aerialite, Ltd.—Mr. L. S. Hargreaves, chairman, reports a heavy order book and says that the problem is how to produce the orders under the present labour difficulties and to make a profit at the same time, with present-day high operating costs and competition. With regard to profits, he feels that the downward trend has been halted and higher profit levels can be expected. He is confident that reasonable profits will continue to be earned and that the dividend policy will continue on a fairly generous basis.

Since the fall-off in demand for television cables at home, he says, the company has secured some large orders from the Continent and at present has a considerable volume of cable going through the factory for the Continental market—Belgium, Italy, Holland, Denmark and Austria—which will help to maintain the volume on this type of production. To obtain such business, extremely competitive quotations must be made.

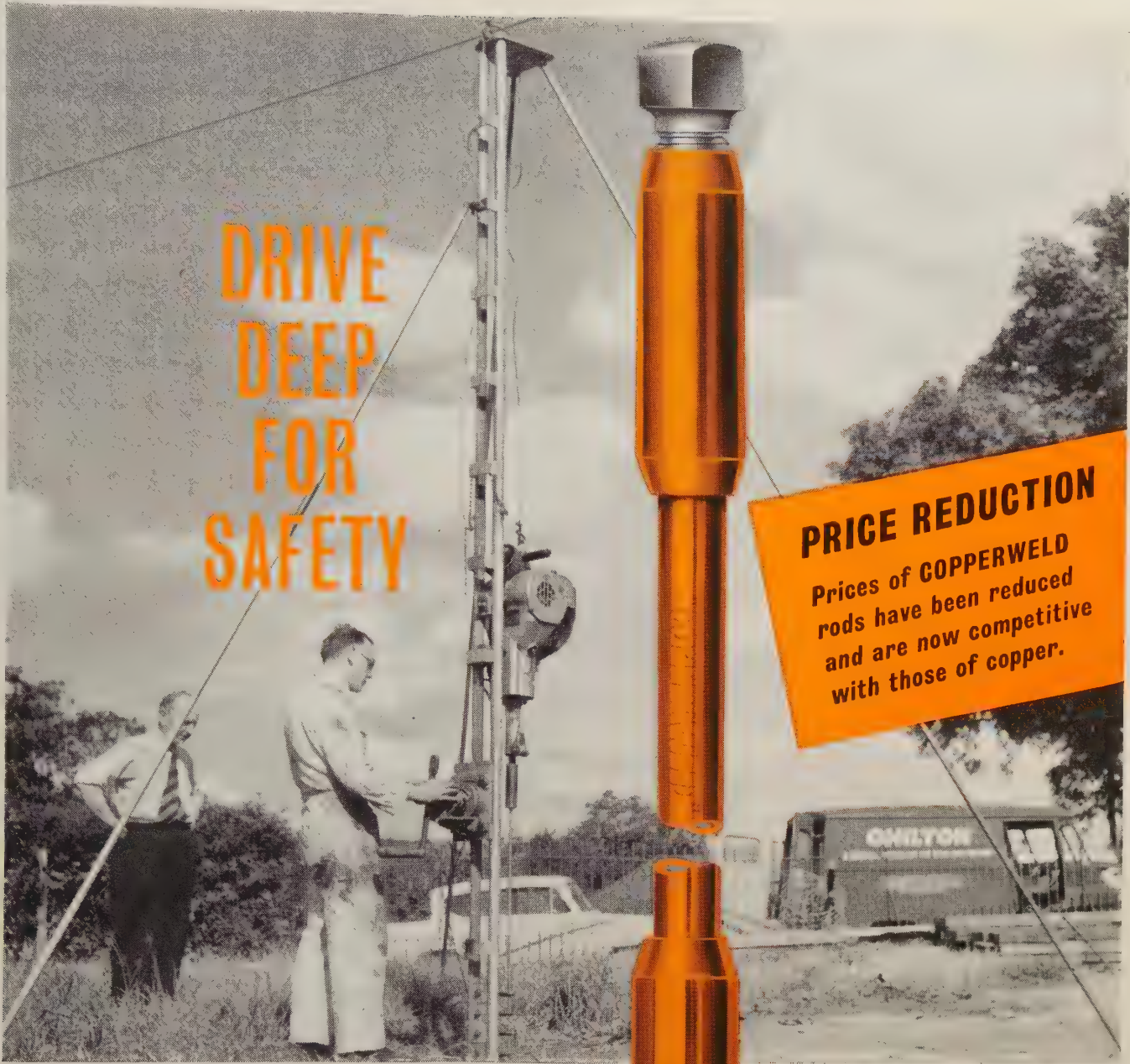
The Nettle division has maintained its profitability, and a better profit has been budgeted for this year than in 1960-61. "By and large," he says, "we can be soberly optimistic in reviewing our trading position up to the present day as far as this financial year has gone."

Mr. Hargreaves says he is not drawing part of his gross dividend, amounting to £6,200, to keep down expenses.

S. Smith & Sons (England).—A final dividend of 12½ per cent makes 20 per cent for the 53 weeks ended 5th August, 1961, which is as for the previous year and as forecast last May.

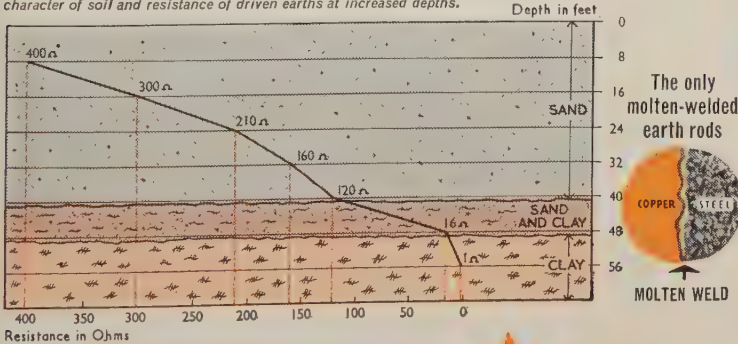
After depreciation, group profits, before tax, fell from £4,190,708 to £2,660,157. The difference between the board's revised forecast in May of "close to" £3 million and the resulting profit is stated to be princi-

(Continued on page 821)



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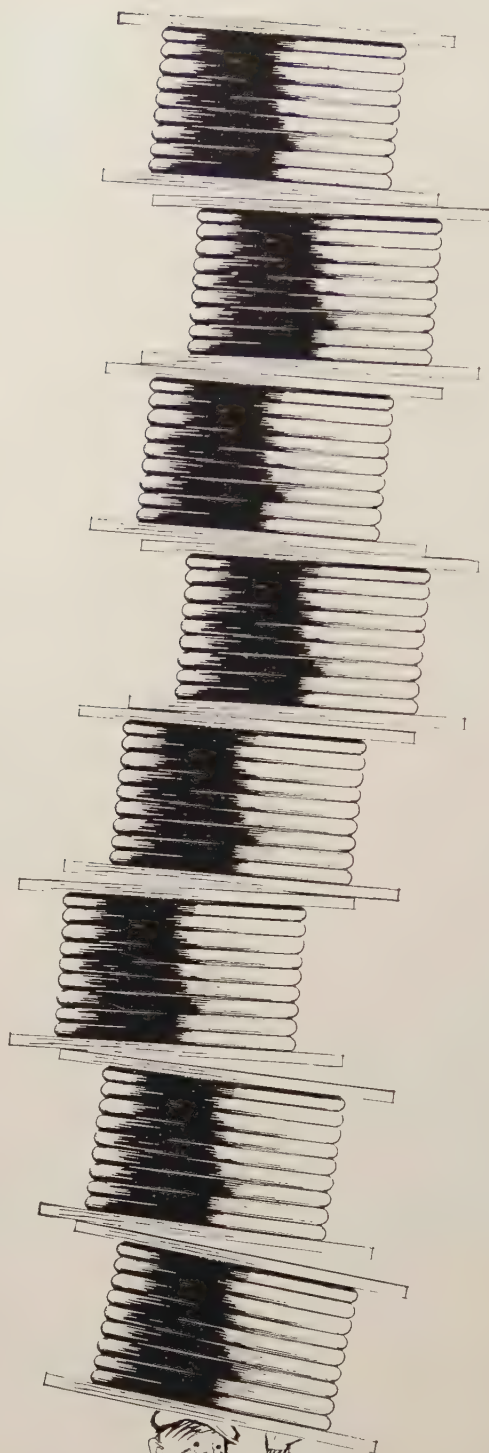
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FACTORIES IN G.T. BRITAIN, AUSTRALIA, SOUTH AFRICA, INDIA AND PAKISTAN

FINANCIAL SECTION (continued)

pally attributable to unofficial strikes in June. Contributory factors included a deterioration in the results of the Australian subsidiary. The net profit of £1,462,426 compares with £2,312,667.

Crabtree Electrical Industries, Ltd., is paying a final dividend of $7\frac{1}{2}$ per cent, making $12\frac{1}{2}$ per cent for the year to 31st July, 1961, the same equivalent as the previous year's total adjusting for a one-for-one scrip issue between the interim and final.

Group trading profit, etc., increased from £557,334 to £611,489, and the net profit is £259,081, compared with £206,063.

Alwyn Holdings, Ltd., is paying a dividend of 15 per cent as forecast for the year to 30th June, 1961, against the equivalent of $8\frac{1}{2}$ per cent, adjusting for a one-for-two scrip issue. The company was made public in June, 1959. Group profit is £232,297, against £186,732 for the previous year, and the net profit is £111,077 (£86,868).

Joseph Lucas (Industries), Ltd., is repeating dividends of 2s 9d per £1 ordinary and redeemable preference shares with a final of 2s 3d per share for the year ended 31st July, 1961.

Sales of products were marginally in excess of those of the previous year but the group's consolidated trading surplus contracted from £7,823,177 to £6,476,846. After all charges and including exceptional items, the net profit of £2,526,350 compares with £2,923,424.

J. & F. Stone Lighting & Radio, Ltd.—Mr. F. S. Bassett, chairman, reports that turnover in the current financial year in respect of new business is higher than that for the corresponding period last year. He points out, however, that the continuance of hire-purchase restrictions and the less prosperous conditions ruling in a number of industries throughout the country are factors which cannot be encouraging to any business dealing in consumer goods.

Group cash resources are in excess of those required for present trading conditions and the directors consider that the best use of the money can be made by financing credit trading. The policy also is to extend substantially the rental activities and to increase the number of branches.

Sun Electrical Co., Ltd.—Profits rose from £150,132 to £181,409 in the year ended 30th April, 1961. The dividend is held at $18\frac{1}{2}$ per cent with an unchanged $13\frac{1}{2}$ per cent final.

Bakelite, Ltd.—Interim dividend 6 per cent (the same).

New Companies

Aron Meters, Ltd.—Registered 6th November. Capital £100. Electrical and mechanical engineers, manufacturers of and dealers in meters for the measurement of the consumption of electricity, etc. Solicitors: Allen & Overy, 9/12, Cheapside, E.C.2.

P. Sanders, Ltd.—Registered 6th November. Capital £100. Manufacturers of and dealers in electrical goods of all kinds, etc. Directors: P. R. Sanders, P. Richards (secretary) and P. R. F. Caldecourt. Regd. office: 3, Bear Road, Hanworth, Feltham, Middx.

Packard Instrument, Ltd.—Registered 6th November. Capital £1,000. Electronic, electrical and mechanical engineers; manufacturers of equipment, apparatus or instruments for use in research into radioactivity and chromatography, etc. Solicitors: Baker, McKenzie & Hightower, 7/8, Norfolk Street, W.C.2.

Comark Electronics, Ltd.—Registered 6th November. Capital £1,000. Designers, developers, manufacturers and distributors of electronic and electromagnetic mechanisms, etc. Secretary: J. R. Ward. Regd. office: 1a, Church Street, Godalming, Surrey.

Elremco Sales, Ltd.—Registered 7th November. Capital £1,000. Electrical and mechanical engineering, etc. Directors: J. K. Chuchla, J. L. J. Stickley and P. Gotley. Solicitors: G. Houghton & Son, 133, Moor-gate, E.C.2.

Liquidations

Winding-up proceedings or liquidations are often undertaken for the purpose of reconstruction, the transfer of a business, or other reasons. The appearance of a company's name under this heading therefore does not necessarily indicate insolvency.

Exelec, Ltd., manufacturers of domestic electrical appliances, 51, Lincoln's Inn Fields, London, W.C.2.—Winding up voluntarily. Liquidator, Mr. J. W. Baggett, 90a, High Street, Highgate Village, London, N.6, appointed by members on 7th November. Particulars of claims to the liquidator by 24th November.

William B. Abel & Son, Ltd., radio, television and electrical engineers, 143, Fisherton Street, Salisbury.—Last day for receiving proofs for dividend 25th November. Liquidator, Mr. G. C. Ehlers, 28, Baldwin Street, Bristol, 1.

G. & T. Electrics, dealers in electrical equipment, 246-8, Plumstead High Street, London, S.E.18.—Meetings of creditors and contributories 21st November at Room 401, Inveresk House, 346, Strand, London, W.C.2.

Don Kenyon Electrical (Nottingham), Ltd.—Particulars of claims to the liquidator, Mr. R. C. Ravensdale, 42, Friar Gate, Derby, by 28th November.

A. Bastin & Co. (Electrical), Ltd., 77, Barking Road, East Ham, London, E.6, electrical engineers.—Liquidator, Mr. A. T. Cheek, Inveresk House, 346, Strand, London, W.C.2, released 9th October.

G. Cousins, Ltd., 42, Tottenham Street, London, W.1, radio and electrical dealers.—Liquidator, Mr. A. W. Hunter, Walter House, 418-422, Strand, W.C.2, released 31st July.

Winding-up Order

Colben Electronic Engineering Co., Ltd., Creco Works, Harwich Street, Whitstable, Kent.—Winding up order made 30th October.

Bankruptcies

G. H. Mattinson, residing and carrying on business at The Forge, Waver Bridge, Wigan, Cumberland, builder and electrical contractor.—Receiving order made 17th October on debtor's petition.

A. C. Hart, radio and electrical engineer, 256, High Street, Berkhamsted, Herts.—First meeting 22nd November at City Gate House,

39-45, Finsbury Square, London, E.C.2. Public examination, 17th January at the County Hall, Aylesbury, Bucks.

J. G. Evans, 3, Richard Street, Northwich, Ches., electrician.—Receiving order made 20th October on debtor's petition. Public examination 11th January, 1962, at the Court House, Nantwich Road, Crewe.

Phoenix Enfield Supplies, 11, Napier Road, Ponders End, Enfield, Middlesex, electrical appliance retailers.—Public examination 12th December at the Court House, Fore Street, Upper Edmonton, N.18.

D. Hill, electrical engineer, lately carrying on business with another at Ongar Road, Brentwood, Essex, and 10, Cromwell Road, Brentwood, Essex, under the style of Brentwood Electronics.—Receiving order made 24th October on debtor's petition.

S. C. Doubleday and K. W. Palmer, lately carrying on business in partnership at Brook Street, Braunston, Oakham, Rutland, under the style of Doubleday & Partner as radio and television dealers and electrical contractors.—Public examination 5th January, 1962, at The Castle, Leicester.

D. C. Peacock, lately residing and carrying on business at 13, Well Road, Maidstone, Kent, and lately carrying on business in partnership with another as Domestic Electric Service at 67-69, King Street, Maidstone.—Receiving order made 31st October on a creditor's petition.

J. A. Inverarity, 8, Stox Mead, Harrow Weald, Middx., lately trading as an electrical sub-contractor and formerly trading as Collins & Partners at 43, Mason's Avenue, Wealdstone, Harrow, Middx., electrical contractors and repairers.—First meeting 21st November and public examination 24th January at Bankruptcy Buildings, Carey Street, W.C.2.

CATALOGUES AND LISTS

DOMESTIC APPLIANCES.—Catalogue, illustrated in colour, covering the company's range of electric fires, fan heaters and desk fans.—**H. Frost & Co., Ltd.**, Walsall, Staffs.

Catalogue with particulars and illustrations in colour of the company's range of domestic heating appliances, including fuel-effect fires, infra-red heaters and a fan heater.—**Gatehill Beco, Ltd.**, Kennard Road, Stratford, London, E.15.

Catalogue containing coloured illustrations and particulars of the "Sofono" range of domestic electric space heating appliances.—**Sofono Electrical Division, Federated Foundries, Ltd.**, 4, Stratford Place, London, W.1.

New season's catalogue (96 pages), containing particulars, prices and illustrations in full colour, of the company's range of domestic heating and cooking appliances. A section at the front of the catalogue gives much useful information on the selection and use of heating appliances, running costs, safety in the home, the Clean Air Act, etc., and illustrations are included of various stages in the manufacture of the company's products.—**Belling & Co., Ltd.**, Bridge Works, Enfield, Middlesex.

Broadsheet on the company's range of domestic clothes drying and airing equipment and a hotplate.—**Modern Equipment Co., Ltd.**, Court Ash, Yeovil, Somerset.

LIGHTING FITTINGS.—Illustrated brochure and price list covering "Aristocrat" lighting fittings and wall brackets produced by the company.—**Allen & Pope, Ltd.**, 1, Birkbeck Mews, Dalston, London, E.8.

Catalogue (48), containing particulars of the company's range of lighting fittings.—**Linolite, Ltd.**, 118, Baker Street, London, W.1.

Series of leaflets dealing with fluorescent lighting fittings and a catalogue (TC/61) covering lamps and tubes.—**Ekco-Ensign Electric, Ltd.**, 45, Essex Street, Strand, London, W.C.2.

Catalogue (C227/2) containing particulars of the company's range of industrial and commercial lighting fittings and a second catalogue dealing with tungsten filament and discharge lamps.—**Cryselco, Ltd.**, Kempston Works, Bedford.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 6d each including postage) are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2

1956

31307. Associated Electrical Industries, Ltd.—Electric selective signalling systems. 14th March, 1958. (880685.)
33312. Cathodic Corrosion Control, Ltd.—Anodes for use in electrolytic protection systems. 28th October, 1957. (Cognate applications 2853, 25th January, 1957, and 2854, 25th January, 1957.) (880519.)
38627. Electric & Musical Industries, Ltd.—Colour television receivers. 6th December, 1957. (Cognate application 6575, 27th February, 1957.) (Addition to 871367.) (880517.)

1957

3369. Electric & Musical Industries, Ltd.—Colour television. 31st January, 1958. (880474.)
3880. Electric & Musical Industries, Ltd.—Electron discharge devices. 5th February, 1958. (880522.)
4522. Murray, J. S.—Transistor amplifier providing a balanced output signal. 7th February, 1958. (880475.)
9881. Associated Electrical Industries, Ltd.—Electric winder control apparatus. 20th March, 1958. (880775.)
10898. Associated Electrical Industries, Ltd.—Electric traction systems. 27th March, 1958. (880686.)
30375. Muilard, Ltd.—Cathode-ray devices. 21st July, 1958. (880477.)
31853. Bloembergen, N.—Microwave signal circuit arrangements. 11th October, 1957. (880478.)
37042. Communications Patents, Ltd.—Apparatus for converting electric signals for analogue computing purposes. 27th November, 1957. (880811.)
39668. Associated Electrical Industries, Ltd.—Pulse generators. 5th February, 1959. (880525.)
40476. Etablissements Davey, Bickford, Smith & Cie. Soc. Anon. Française.—Electric couplings. 31st December, 1957. (880701.)

1958

4119. Inoue, K.—Electric spark machining apparatus. 7th February, 1958. (880709.)
4231. Kober, W.—Self-regulating electric generator and regulator. 10th February, 1958. (880711.)
4448. Compagnie Française Thomson-Houston.—Control of electrically operated machines particularly washing machines. 11th February, 1958. (880712.)
5067. Philips Electrical Industries, Ltd.—Voltage measuring arrangements. 17th February, 1958. (880921.)
5211. Inductosyn, Ltd.—Reduction of single-turn loop coupling in position measuring transformer. 18th February, 1958. (880727.)
5455. British Broadcasting Corporation.—Circuits embodying reactive devices. 19th February, 1959. (880728.)
7048. High Voltage Engineering Corporation.—High voltage apparatus. 5th March, 1958. (880877.)
11379. Fernseh G.m.b.H.—Temperature dependent transistor circuit arrangements. 10th April, 1958. (880492.)
12801. National Research Development Corporation.—Two-state electronic circuits. 16th April, 1959. (880563.)
12952. Siemens & Halske A.G.—Cooling systems of high power electronic tubes. 23rd April, 1958. (880493.)
15313. Edwards High Vacuum, Ltd.—Cathode-ray tubes. 5th May, 1959. (880800.)
17907. Marconi's Wireless Telegraph Co., Ltd.—Piezo-electric crystals. 5th March, 1959. (880557.)

18152. Standard Telephones & Cables, Ltd.—Radio receiving system. 6th June, 1958. (880925.)
18154. Standard Telephones & Cables, Ltd.—Electric capacitor made by thermal evaporation of various materials forming alternating metallic and insulating layers. 6th June, 1958. (880546.)
19004. Standard Telephones & Cables, Ltd.—Test set for testing radio navigation equipment. 13th June, 1958. (880566.)
21228. Siemens & Halske A.G.—Processes for the manufacture of semiconductor single crystals and apparatus therefor. 2nd July, 1958. (880559.)
21231. Manufacture de Bethune.—Electrically operated automatic platform scales. 2nd July, 1958. (880740.)
26956. A. H. Hunt (Capacitors), Ltd.—Supporting devices for electrical components. 20th August, 1959. (880930.)
30835. International Business Machines Corporation.—Switching devices. 26th September, 1958. (880574.)
34384. Telemecanique Electrique.—Monitoring circuit for three-phase supply systems. 27th October, 1958. (880742.)
35857. C. A. Parsons & Co., Ltd.—Nuclear reactors. 26th October, 1959. (880697.)
36726. National Research Development Corporation.—Valve voltmeters. 28th October, 1959. (880741.)
41766. Fairhurst, J.—Electrical transducers. 24th December, 1959. (880437.)

1959

274. Sperry Gyroscope Co., Ltd.—Transistor amplifier. 18th December, 1959. (880763.)
1567. Thorn Electrical Industries, Ltd.—Electrical inductors. 2nd December, 1959. (880814.)

20163. United States Atomic Energy Commission.—Thermonuclear reactor and a method of initiating and sustaining a thermonuclear reaction. 12th June, 1959. (880124.)
25188. Associated Electrical Industries, Ltd.—Method of testing the inter-turn insulation of multi-turn electric coils. 8th July, 1960. (880306.)
28648. Nippon Electric Co., Ltd.—Means for coupling between the rotating and fixed parts for an electric signal transmission system. 21st August, 1959. (880227.)
28763. Automatic Telephone & Electric Co., Ltd.—Telephone systems. 28th July, 1960. (880076.)
28927. Foxboro Co.—Electrically operated apparatus for remote measuring. 24th August, 1959. (880164.)
31867. United Kingdom Atomic Energy Authority.—Steam generators. 11th August, 1960. (880230.)

1960

1977. Bofors A.B.—Safety rod for liquid-cooled, liquid-moderated nuclear reactor. 19th January, 1960. (880461.)
5842. Maschinenfabrik Oerlikon.—Arrangement for suppressing the transmission of vibrations from the stations of electrical machinery to the bearings and foundations. 18th February, 1960. (880900.)
7566. Philips Electrical Industries, Ltd.—Photo-electric tubes. 3rd March, 1960. (880799.)
9399. Standard Telephones & Cables, Ltd.—Diversity radio receiving arrangements. 17th March, 1960. (880673.)
10483. General Electric Co.—Polytetrafluoroethylene resin insulated electrical conductors. 24th March, 1960. (880648.)
28452. Bosch G.m.b.H., Robert.—Generators. 17th August, 1960. (880951.)

Trade Mark Applications

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 1st December.

Hellermann. No. B820,459. Class 6. Material composed principally of common metal, for identifying electric cables, pipelines and the like.—Hellermann, Ltd., Gatwick Road, Crawley, Sussex.

Servalco. No. 799,301. Class 7. Rotary electromechanical machines. **Servalcosyn.** No. 799,303. Class 7. Synchro generators, motors and systems.—Société d'Electronique et d'Automatisme, Paris. Address for service: G. F. Redfern & Co., Redfern House, Dominion Street, London, E.C.2.

Triomatic. No. 817,108. Class 7. Washing machines.—Bendix Home Appliances, Ltd., Abion Works, Kingsbury Road, Birmingham.

Newman Seal. No. B818,744. Class 7. Electric motors (not for land vehicles).—Newman Industries, Ltd., Yate, Bristol.

Rotostat. No. 822,961. Class 7. Electric motors (not for land vehicles).—Ancienne Manufacture d'Horlogerie, Patek, Philippe & Co., Geneva. Address for service: Boulton, Wade & Tennant, 112, Hatton Garden, London, E.C.1.

Bendix. No. B803,745. Class 9. Electrical and electronic apparatus and installations for use in the automatic or remote control of industrial operations and of vehicles; computers; electron tubes (not for lighting purposes); radio direction finders; counting machines; timing devices; fuses; wiring harnesses; relays; switches; trans-

formers; voltage regulators; semiconducting devices; television receivers; accumulators, etc.—Bendix Corporation, U.S.A. Address for service: Frederick J. Cleveland, 302-306, Bank Chambers, 329, High Holborn, W.C.1.

Klixon. No. B804,177. Class 9. Thermostats and thermostatic elements; electric switches and circuit-breakers, all being thermally or thermostatically actuated; and electromagnetic relays.—Texas Instruments, Inc., U.S.A. Address for service: Abel & Imray, Quality House, Quality Court, Chancery Lane, London, W.C.2.

Jastac. No. 813,669. Class 9. Electrical connections, contacts and inserts.—J. & S. Engineers, Ltd., 1a, London Road, Crayford.

Elkomold. No. 817,737. Class 9. Electrical capacitors in moulded casings. **Elkopack.** No. 817,738. Class 9. Capacitors.—Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3.

Paratherm. No. 819,830. Class 9. Scientific and electrical apparatus and instruments; thermostats, circuit-breakers, temperature gauges (semiconductor devices), thermally operated electrical switch contacts, and automatic temperature regulators.—Alfred Odenwald, trading as Firma Kontaktwerk Enzberg Ing. Alfred Odenwald, Germany. Address for service: H. D. Fitzpatrick & Co., 94, Hope Street, Glasgow, C.2.

Spacemaker. No. 793,657. Class 9. Electrical, electronic, radio, television and telecommunication apparatus, but not including electrical computing apparatus.—Pilot Radio & Television, Ltd., 31/37, Park Royal Road, London, N.W.10.

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 243a, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged, but, in some cases, not yet announced

MONDAY, 20th NOVEMBER

Arborefield.—Unit Cinema, 3 (Te's.) Training Bn., R.E.M.E., 7 p.m. I.E.E. London Graduate and Student Section. "History of Modern Television," by A. D. G. Wheatley.

Bedford.—Swan Hotel, 7 p.m. I.E.E. Bedfordshire Sub-Centre. "Some Recent Advances in Semiconductor Circuits," by Dr. G. B. B. Chaplin. Joint meeting with the East Midland Electronics and Control Group.

Brigg.—Angel Hotel, 6.30 p.m. I.E.E. North Midland Centre, Sheffield Sub-Centre. "A General Theory of Depreciation of Engineering Plant," by D. Rudd. Joint meeting with North Lincolnshire District.

Bristol.—Demonstration Theatre, Electricity House, Colston Avenue, 6 p.m. I.E.E. Western Supply Group. "The Manufacture, Properties and Use of Some of the New Insulation Materials for the Electrical Industry," by K. Pollard.

Grand Hotel, 8 p.m. A.S.E.E. Bristol and West of England Branch. "Principles of Radio and Television Communication," by R. E. Griffin.

Chelmsford.—White Hart Hotel, Tindal Street, 7.45 p.m. A.S.E.E. Mid-Essex Branch. "The Aims and Objects of the Electrical Association for Women," by Mrs. S. T. Gunstone.

Chester.—Town Hall, 6.30 p.m. I.E.E. Mersey and North Wales Centre. "Transistors," by P. Godfrey.

Leeds.—British Lighting Council, 24, Aire Street, 6.15 p.m. I.E.S. Leeds Centre. "Continental Lighting Practice," by A. W. Gostt.

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Discussion on "Electrical Accidents and their Causes, including the Legal Aspects," to be opened by S. J. Emerson.

John Adam Street, Adelphi, W.C.2, 6 p.m. Royal Society of Arts. Cantor Lecture. "Some Problems of British Export Trade—Exports and the Country's Economy," by J. L. S. Steel.

Manchester.—Electrical Engineering Laboratories, University, Dover Street, 6.15 p.m. I.E.E. North Western Centre, Education Discussion Circle. Discussion on "Exchange of Ideas on Laboratory Experiments."

Newcastle-upon-Tyne.—Rutherford College of Technology, Northumberland Road, 6.15 p.m. I.E.E. North Eastern Measurement and Electronics Group. "Simulation of Intelligence," by Dr. D. M. Mackay.

Sheffield.—Dog and Partridge Hotel, 7.30 p.m. A.S.E.E. Sheffield Branch. Ladies' night.

TUESDAY, 21st NOVEMBER

Bristol.—Colston Hall, 6.30 p.m. I.E.E. Western Centre. Faraday Lecture. "Expanding Horizons in Communications," by D. A. Barron.

Cheltenham.—Belle Vue Hotel, 7.30 p.m. Society of Instrument Technology, Cheltenham Section. "Automatic Railway Signalling," by J. A. Heald.

Fareham.—H.M.S. "Collingwood," 7.30 p.m. A.S.E.E. Portsmouth and District Branch. "Safety in the Utilisation of Electricity," by S. J. Emerson.

Glasgow.—Grosvenor Restaurant, Gordon Street, 6 p.m. I.E.E. Scottish Centre. Annual dinner-dance.

39, Elmbank Crescent, C.2, 6.30 p.m. Institution of Engineers and Shipbuilders in Scotland. "Lloyd's Rules for Electrical Equipment of Ships—Some Underlying Considerations," by D. Gray.

Leeds.—Leeds and County Conservative Club, South Parade, 6.30 p.m. I.E.E. North Midland Centre, Utilisation Group. "A Survey of Street Lighting and its Future," by W. R. Stevens and H. M. Ferguson.

Liverpool.—Industrial Development Centre, Paradise Street, 6 p.m. I.E.S. Liverpool

Centre. "Office Lighting," by R. G. Hopkinson and J. Longmore.

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Measurement and Control Section. Discussion on "The Precision Required in the Calibration of Industrial Instruments," to be opened by P. M. Clifford and A. Felton.

Great George Street, Westminster, S.W.1, 5.30 p.m. Institution of Civil Engineers. "The Main Building for the 7 GeV Proton Synchrotron at Harwell," by S. A. Rossiter and J. S. Brown.

Luton.—Half-Way House, Dunstable Road, 7.30 p.m. Institution of Production Engineers, South Eastern Region. "Static Switching Applied to Machine Tool Control," by W. G. Turner.

Manchester.—Engineers' Club, Albert Square, 6.15 p.m. I.E.E. North Western Centre, Measurement and Control Group. "Transistor Instrumentation in Rockets," by G. G. Haigh.

Portsmouth.—C.E.G.B. Offices, High Street, 6 p.m. I.E.E. Southern Electronics and Control Group. "The Application of Electrical Phenomena at Liquid Helium Temperatures," by Dr. R. E. Hayes.

Preston.—Demonstration Theatre, North Western Electricity Board, 19, Friargate, 6.30 p.m. I.E.S. North Lancashire Group. "The New I.E.S. Code," by W. Robinson.

Tonbridge.—Rose and Crown Hotel, 7.30 p.m. A.S.E.E. West Kent Branch. "Electricity on the Dairy Farm," by P. Wakeford.

WEDNESDAY, 22nd NOVEMBER

Birmingham.—Birmingham and Midland Institute, Paradise Street, 6.30 p.m. I.E.E. South Midland Centre. "Experimental Investigation of Space," by J. A. Ratcliffe. Joint meeting with the Institutions of Civil and Mechanical Engineers.

Cambridge.—Engineering Department, University, Trumpington Street, 6 p.m. I.E.E. Cambridge Electronics and Measurement Group. "Recording of High Speed Phenomena," by Dr. C. W. B. Grigson.

Didsbury.—Mersey Hotel. I.E.E. North Western Centre, Graduate and Student Section. Buffet dance.

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Supply Section. "Electronic Analogue Computer Simulation of Multi-Machine Power System Networks," by Dr. A. S. Aldred; and "Analysis of Overall Stability of Multi-Machine Power Systems," by J. G. Miles.

1, Birdcage Walk, Westminster, S.W.1. Institution of Mechanical Engineers. James Clayton Lecture. "Reflections on the Institution's Role in Engineering Education," by Prof. E. Giffen.

Norwich.—Flixton Room, Samson and Hercules House, 6.30 for 7.15 p.m. Norfolk Electrical Circle. Annual dinner.

Walton-on-Thames.—Transformer and Rectifier Sections, Hackbridge & Hewitt Electric Co., Ltd., Molesey Road, Hersham, 2 p.m. I.E.E. London Graduate and Student Section. Visit.

Winchester.—Abbey House, 6.30 p.m. I.E.E. Southern Centre. "Construction, Operation and Maintenance of 132 kV and 275 kV Overhead Grid Lines," by J. A. Wakefield and H. G. New.

THURSDAY, 23rd NOVEMBER

Belfast.—Central Hall, Rosemary Street. A.S.E.E. Northern Ireland Centre. "An Informal Talk," by Dr. D. S. McIlhagger.

Birmingham.—Electrical Engineering Department, University, 6.15 p.m. British Institution of Radio Engineers, West Midlands Section. "Tunnel Diodes," by Dr. K. Hu'me.

Cardiff.—Sophia Gardens Pavilion, 6.45 p.m. I.E.E. Western Centre. Faraday Lecture. "Expanding Horizons in Communications," by D. A. Barron.

Chester.—Stanley Palace, Watergate Street, 7 p.m. Society of Instrument Technology, Chester Section. "Transistors Applied to Modern Instrumentation," by J. E. Fielden.

The Blossoms, 7.15 p.m. Institution of Plant Engineers, Merseyside and North Wales Branch. "Refractories for Boilers and Furnaces—Construction and Maintenance," by M. Ash and N. W. Hinchcliffe.

Chippenham.—Technical College, 7 p.m. I.E.E. Western Centre, Bristol Graduate and Student Section. "Engineering Blind Spots," by W. Ford.

Croydon.—Greyhound Hotel, 8 p.m. A.S.E.E. South London Branch. "The National Inspection Council for Electrical Installation Contracting," by E. J. Sutton.

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Electronics and Communications Section. "The B.B.C. Television Centre and its Technical Facilities," by F. C. McLean, H. W. Baker and C. H. Colborn.

Savoy Place, W.C.2, 6 p.m. I.E.E. Education Discussion Circle. Discussion on "The 57 Effects of an Electrical Current," to be opened by Dr. G. S. Brosnan.

Nottingham.—People's College of Further Education, Castle Road, 7.30 p.m. A.S.E.E. Nottingham Branch. "Plastics in the Electrical Industry," by A. J. Moulam.

Southampton.—University, 6.30 p.m. I.E.E. Southern Centre, Graduate and Student Section. "Magnetohydrodynamic Power Generation," by R. Hawley.

Polygon Hotel, 8 p.m. A.S.E.E. Southampton Branch. "Electric Water Heating."

Sunderland.—Technical College, 6.30 p.m. I.E.E. North Eastern Graduate and Student Section. "The Silicon Controlled Rectifier, a New Tool for the Power Engineer," by R. Dunn.

FRIDAY, 24th NOVEMBER

Aylesbury.—Technical College, Walton Road, 7.30 p.m. A.S.E.E. Oxford and Districts Branch. "Power Factor Correction," by T. A. Williams.

Birmingham.—College of Advanced Technology, Gosta Green, 6.15 p.m. I.E.E. South Midland Centre, Education Discussion Circle. Discussion on "A Materials Course for Electrical Engineers," to be opened by Dr. G. T. Wright.

Cardiff.—St. Mellons County Club. I.E.S. Cardiff Centre. Dinner-dance.

Coventry.—Conservative Rooms, 16, Queens Road, 8 p.m. A.S.E.E. Coventry and District Branch. "Industrial Motor Control Gear," by B. Bardell.

Edinburgh.—Bruntsfield Hotel, Bruntsfield. Institution of Plant Engineers, Edinburgh Branch. Dinner and dance.

Glasgow.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, C.2, 12.30 p.m. I.E.S. Glasgow Centre. Luncheon meeting.

Halifax.—Old Cock Hotel. A.S.E.E. Halifax Branch. Annual dinner.

Hanley.—Grand Hotel, 7.30 p.m. A.S.E.E. Stoke and Crewe Branch. "Temperature Control," by L. Clarke.

London.—Pepys House, 14, Rochester Row, Westminster, S.W.1, 7 p.m. Junior Institution of Engineers. Annual meeting.

Manchester.—Grand Hotel. Institution of Plant Engineers, Manchester Branch. Annual dinner.

Stone.—Crown Hotel, 8.30 p.m. I.E.E. North Staffordshire Sub-Centre. Joint annual dance with the Graduate and Student Section.

SATURDAY, 25th NOVEMBER

Glasgow.—Ca'dora Restaurant, 122, Union Street. Institution of Plant Engineers, Glasgow Branch. Dinner and dance.

London.—Waldorf Hotel. Institution of Plant Engineers, London Branch. Dinner and dance.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Australia.—State Electricity Commission of Victoria, 4th December. 180 and 15 kVA outdoor capacitors. (E.S.B. 34620/61.)* 11th December. Switchboard type instruments. (E.S.B. 34335/61.)*

New South Wales Electricity Commission, 8th January. Three 330 kV, 100 MVA single-phase auto-transformers. (E.S.B. 34071/61.)*

Mackay Regional Electricity Board, 29th November. Outdoor circuit-breakers. (E.S.B. 34934/61.)*

Southern Electric Authority, 30th November. Eight 33/11 kV transformers. (E.S.B. 34998/61.)*

Ayr.—Town Council, 1st December. Underground cable. (See Classified Advertisement Section.)

Colombia.—Instituto Nacional de Fomento Municipal, Departamento Comercial, Bogota, 30th November. Two diesel-electric generating sets for Puerto Tejada (Cauca) and Mompos (Bolívar). (E.S.B. 34633/61.)*

Egypt.—Cairo Electricity and Gas Administration, 7th March. Six 200 tons/hr oil-fired boilers and three 60 MW turbo-generators and ancillary equipment, with alternative tender for eight 150 tons/hr boilers and four 45 MW sets. (E.S.B. 34603/61.)*

India.—India Store Department, 28th December. Intercommunication system for Chandrapura thermal power station, 4th January. 415 V motor control centres, 9th January. Ash handling plant, 11th January. Coal transportation and handling plant and auxiliaries. (See Classified Advertisement Section.)

Eastern Railway, Calcutta, 9th April. Signalling equipment. (E.S.B. 34651/61.)*

Singareni Collieries Co., Ltd, 18th December. Forty flameproof circuit-breakers. (E.S.B. 34666/61.)* 20th December. 200 circuit-breakers. (E.S.B. 34667/61.)*

Director General of Supplies and Disposals, 28th November. Two 25 MVA synchronous condensers. (E.S.B. 34989/61.)*

Iraq.—Directorate General of Planning and Design, 2nd December. 115 outdoor transformers, 11,000/400/200 V. (E.S.B. 34975/61.)*

Leeds.—Corporation, 15th December. Street lighting equipment. (See Classified Advertisement Section.)

New Zealand.—State Electricity Department, Wellington, 13th February. Busbars. (E.S.B. 34093/61.)*

Northampton.—Education Committee. Electrical work in Barry Schools. (See Classified Advertisement Section.)

Rushden.—U.D.C., 1st December. Supply and fitting of electric water heaters in 65 houses, Tennyson Road and Westfield Avenue. A. G. Crowley, clerk, Council Buildings, Rushden, Northants.

Wrexham.—Corporation, 4th December. Electrical installations in 108 dwellings. (See Classified Advertisement Section.)

ORDERS PLACED

Beddington and Wallington.—Corporation. Recommended. Rewiring of 112 pre-war properties (£3,830).—M. & B. Electrical.

Bedfordshire.—North West Metropolitan Regional Hospital Board. Recommended. Electrical engineering services, Luton and

Dunstable Hospital (£71,066).—James Kilpatrick & Son.

Birmingham.—Regional Hospital Board. Recommended. Rewiring work at Blackwell Recovery Hospital, Bromsgrove (£5,966).—H. W. Osborne.

Brierley Hill.—U.D.C. Installation of the electrical services for the Assembly Hall, Phase III, at the Civic Buildings (£3,953).—Williams Bros.

Chatham.—Corporation. Installation of electric street lighting (£75,335).—Eleco.

Glasgow.—Housing Committee. Installation of six electric passenger lifts, Ladywell housing development scheme (£34,204).—A. P. Steven.

London.—County Council. Provision of electric water heaters for 405 dwellings at the Becontree estate (£22,090).—F. J. Baynes & Co.

Middlesex.—County Council. Lighting of the Wraysbury Roundabout on the Staines by-pass (£3,003).—Atlas Lighting Co.

Ripon.—City Council. Supply and erection of 24 street lighting columns and fittings for Class "A" lighting, and 103 street lighting columns and fittings for Class "B" lighting (£5,310).—A.E.I. Lamp & Lighting Co.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Ayr.—Shops, hotel, offices and supermarket, Alloway Street/Dalblair Road site (£600,000); Murrayfield Development Co., 144, West George Street, Glasgow.

Berwick.—Supermarket at Marygate; E. S. Boyer & Partners, architects, 88, Gray's Inn Road, London, W.C.1.

Bishop's Stortford.—Dwellings (83), Plaw Hatch Close; U.D.C. surveyor, Council House, The Causeway.

Bredbury.—Factory; Edibrac, Ltd., Hartington Road, Broadheath, Cheshire.

Burnley.—Workshops and offices; Holden & Hartley, Ltd., Trafalgar Street.

Cheshire.—Clinic and divisional health offices, Stalybridge (£60,000), and College of Further Education, Macclesfield (£110,000); county architect, County Hall, Chester.

Eastbourne.—Factory, Brampton Road; Bonded Bearings, Ltd., Station Road, Langley, Bucks.

Ellesmere Port.—Oil terminal, Stanlow; Total Oil Products (G.B.), Ltd., Seymour Mews House, Weymouth Street, W.1.

Glasgow.—Ten-storey hotel, Jamaica Street/Clyde Street site (£450,000); Great Universal Stores, Ltd., Tottenham Court Road, London, W.1.

Greenock.—Houses (46) and seven shops, Central Station Avenue (£150,000); borough surveyor, Municipal Buildings, Wallace Square.

Greenwich.—Flats and maisonnettes (54), Vanbrugh Park; Bell Properties, Ltd., 49, Charles Street, London, W.1.

Harrow.—Office block, College Road; Equitable Debenture & Assets Corp., Ltd., 11, Park Place, London, S.W.1.

Hayes (Middx.).—Luxury flats, Uxbridge Road; Theo H. Birks, architect, 38, Portland Place, London, W.1.

High Wycombe.—Methodist church, Desborough Road; Alister Macdonald & Partners, architects, 10, Bedford Street, London, W.C.1.

Huddersfield.—County secondary school with swimming bath and civic youth centre; planning officer, High Street Buildings.

Kidderminster.—Special day school (£54,250) and second instalment of Shenstone Training College (£106,000); director of education, Castle Street, Worcester.

Liverpool.—Multi-storey flats, Palatine Street; city architect.

London.—Houses and flats (74), Croxted Road, Dulwich; Austin Vernon & Partners, architects, 5, Buckingham Place, S.W.1.

Shops, offices and flats, Hornsey Road, Holloway; Ivor Hodges, architect, 10, Gray's Inn Square, W.C.1.

Loughborough.—Extensions to Training College on Martin Hall site (£585,440); county architect, Leicester.

Showrooms and offices, Market Place; East Midlands Gas Board, University Road, Leicester.

Civic centre (£300,000); J. S. Bates, borough engineer, Southfields.

Maidstone.—Houses (58), Park Wood estate; borough engineer, Palace Avenue.

Middlesex.—Mental health recuperative hostel, Hayes Park (£49,700) and old people's homes, Vernon Drive, Harrow (£76,500) and Stapleton House site, Potters Bar (£105,940); county architect, 1, Queen Anne's Gate Buildings, London, S.W.1.

Ottery St. Mary.—Factory, Yonder Street; Mec Test-McCabe Communications, Ltd., Tale House, Payhembury, Honiton.

Penicuik.—Factory; Wm. Thyne (Plastics), Ltd., Sighthill, Edinburgh.

Peterborough.—Ambulance station at Dogsthorpe (£39,430); city engineer.

Poole.—Office block; Lanteglos, Ltd., Commercial Road.

Preston.—Outpatients' department, Sharoe Green Hospital; Manchester Regional Hospital Board, Cheetwood Road, Manchester, 8.

St. Albans.—Flats (80), Lemsford Road; city surveyor, 16, St. Peter's Street.

St. Helens.—Factory for Delta Metal Co., Ltd.; Robert M. Douglas, Ltd., 395, George Road, Birmingham, 23.

Sedgefield.—Houses (150), at Spring Lane; G. T. Bainbridge & Son, 44, High Row, Darlington.

Southend-on-Sea.—Old people's block, Connaught House site (£65,000); borough architect, 30, Alexandra Street.

Twelve-storey office block, Victoria Avenue; Ernest S. Boyer & Partners, architects, 88, Gray's Inn Road, W.C.1.

South Shields.—Houses (129), at Simon-side, for the T.C.; Whittall, Ltd., builders, West Boldon, Co. Durham.

Spalding.—Proposed new offices for Welland River Board in Marsh Road; W. E. Norman Webster & Son, architects, Station Street, Spalding, Lincs.

Stockport.—Four-acre housing estate; Hampson & Kemp, Ltd., 4, Crossland Road, Manchester, 21.

Sunderland.—Maisonnettes (156) in the Parade area, and houses (545) on an extension to Town End estate; borough architect, Grange House, Stockton Road.

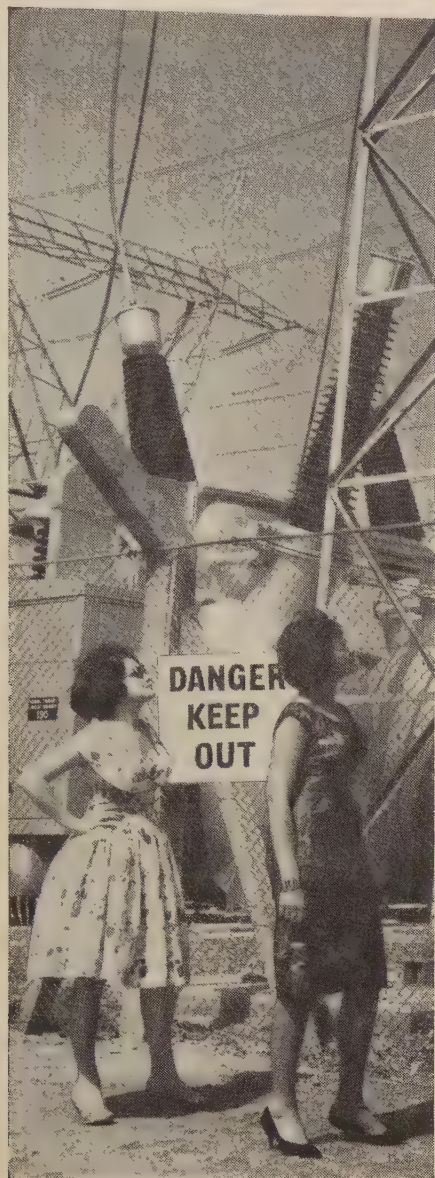
Walsall.—Flats (120), Lower Farm Estate, Phase II; M. E. Habershon, borough engineer, Council House.

Ware.—Extensions to girls' grammar school (£239,249); county architect, County Hall, Hertford.

Watford.—South West Herts. College of Further Education, Water Lane; F. C. Sage, borough engineer, Town Hall.

Wellingborough.—Supermarket, Market Street; Tesco Stores, Ltd., Delamere Road, Cheshunt, Herts.

* This information is extracted from the Board of Trade Export Service Bulletin. Inquiries should be addressed to the Board of Trade, Export Services Branch, Lacon House, Theobald's Road, London, W.C.2 (Telephone: Chancery 4411, Ext. 738), quoting the reference given.



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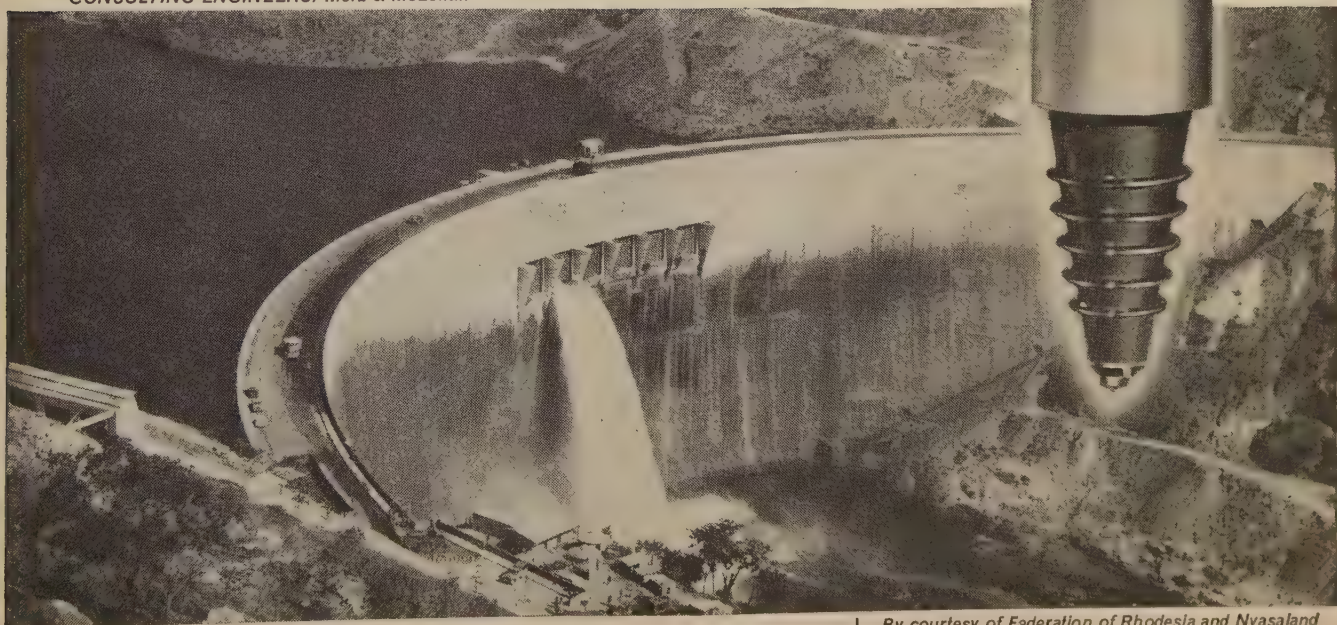
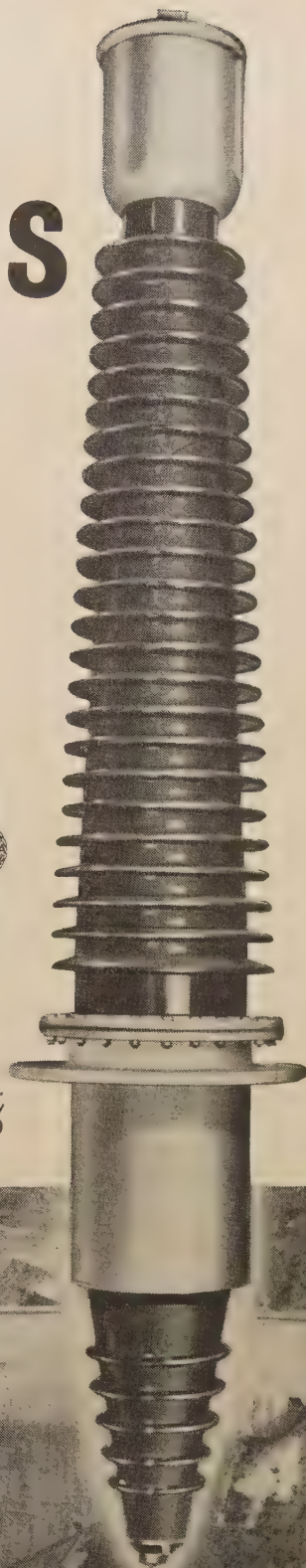
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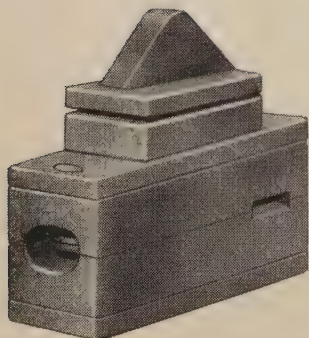
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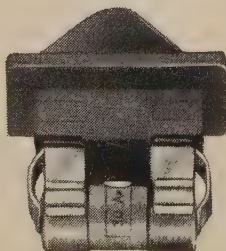
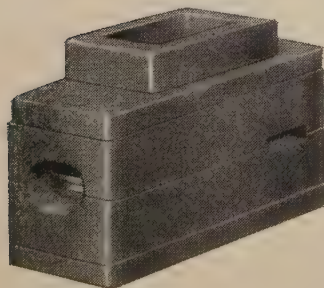


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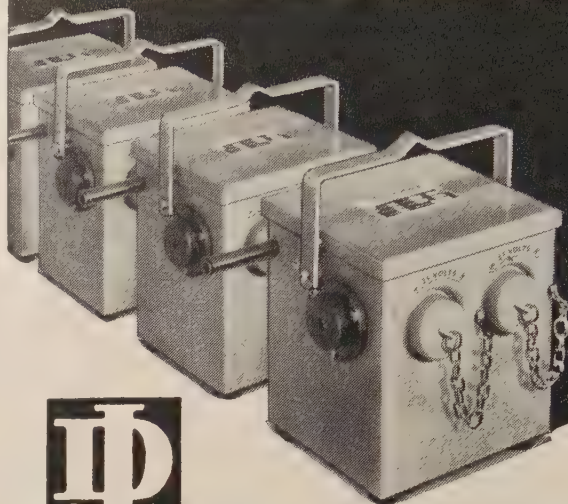
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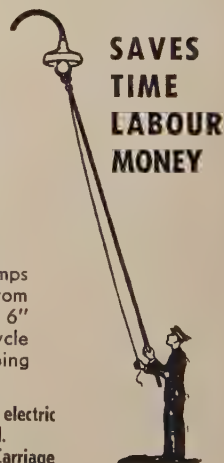
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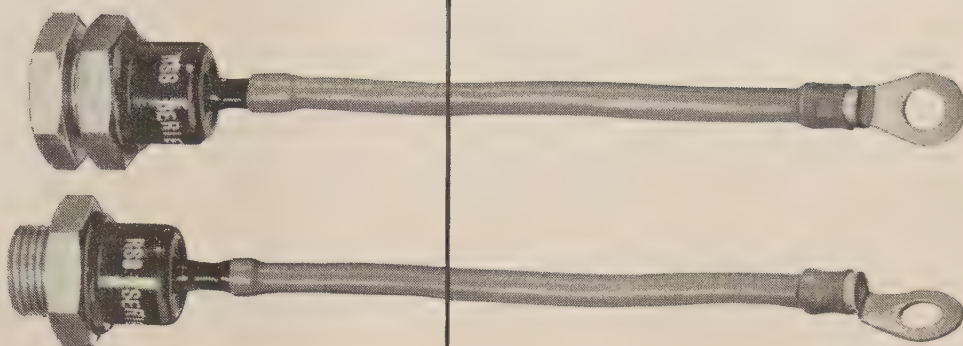


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Maximum current (half wave resistive load) at maximum rated stud temperature 100 amperes mean DC

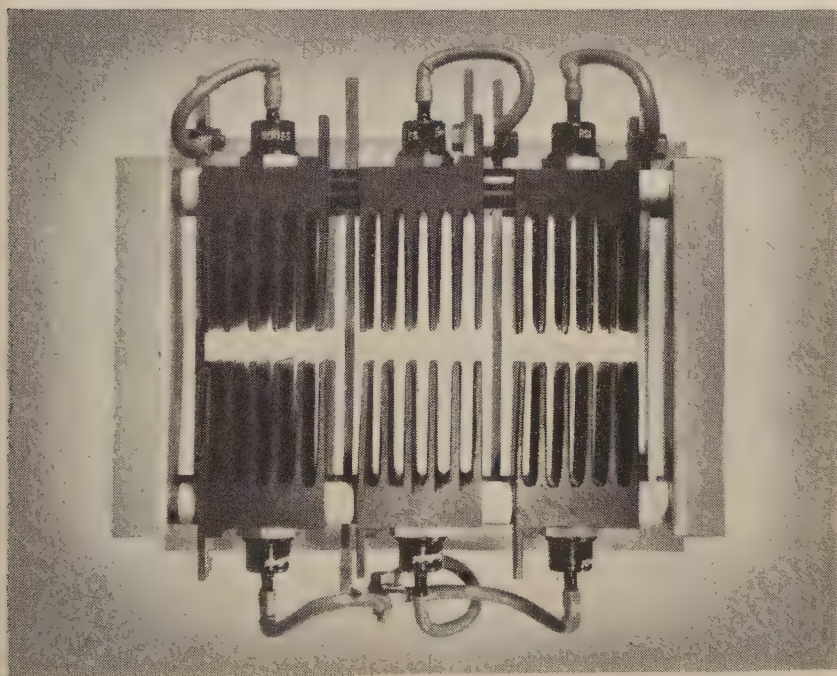
Maximum rated stud temperature 100°C

Maximum mean dissipation (with suitable heat sink) 150 watts

CHARACTERISTICS OF SINGLE DIODES

Maximum forward voltage at 100 amperes at maximum rated stud temperature 1.2 volts

Full-cycle average reverse current at rated C.W.V. at maximum junction temperature 15 milliamperes



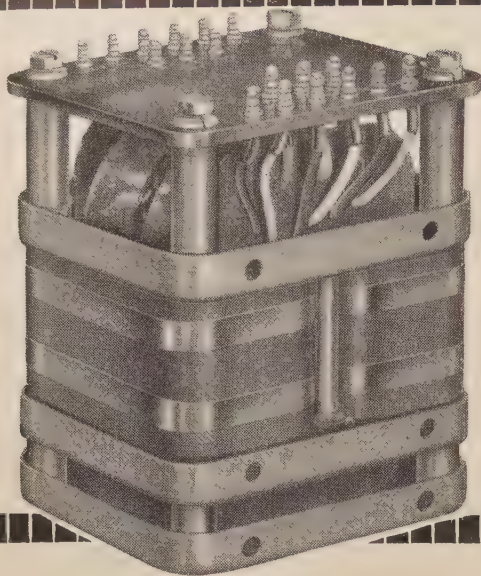
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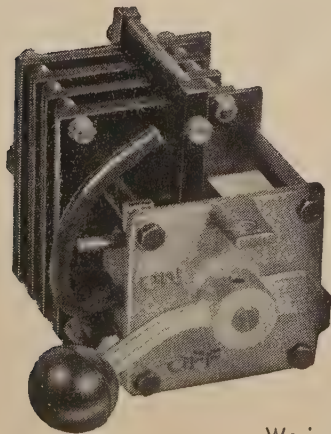
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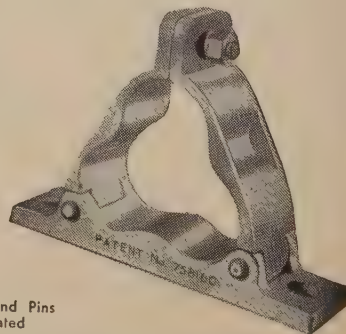
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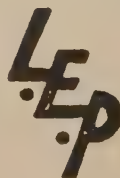
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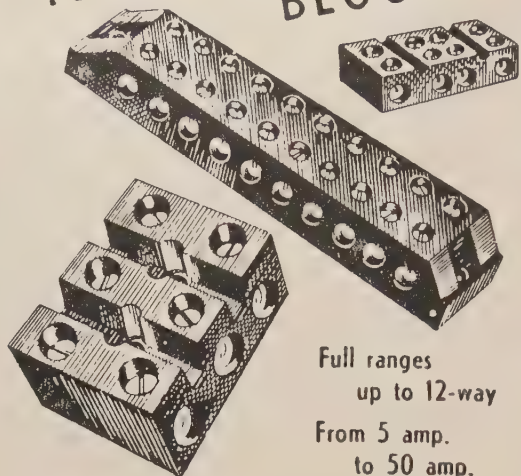
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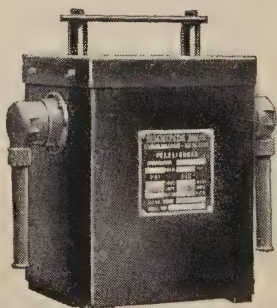
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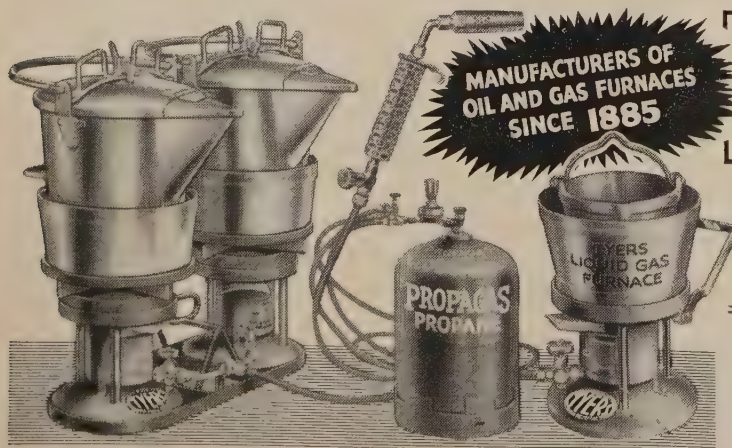


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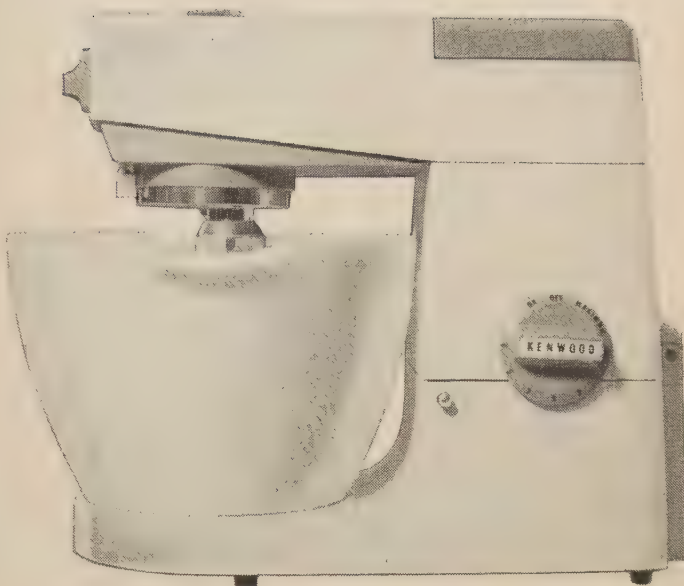
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THE WORLD'S MOST WANTED FOOD PREPARATION MACHINE!

Women want the Kenwood Chef because no other machine has so many attachments—does so many difficult, time consuming and messy jobs for them. It helps with every meal—from a welsh rarebit to a four-course dinner! And once they've bought the basic Chef, they come back again to buy the Chef's attachments. Widely advertised in the national press, full-colour pages in leading magazines and at your local cinema...the famous Kenwood Chef is always in demand!

Kenwood Chef standard pack includes mixing bowl, three beaters, and 126-page recipe and instruction book.

RETAIL PRICE £24.9.7 + £4.18.5 PT

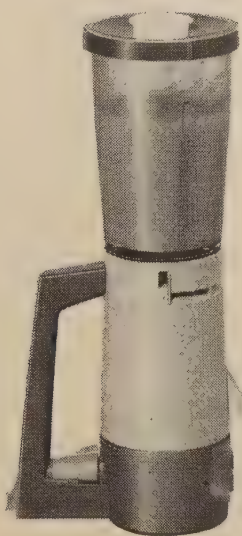


NEW! Kenwood Chefette

Backed by TV and press advertising, this modestly-priced, outstandingly designed and useful machine is certain to have phenomenal sales success!
RETAIL PRICE £9.7.4 + £1.17.8 PT



THIS WAY The Chefette is the quickest, sturdiest, portable electric mixer—with three speed adjustment—for all mixing. Mashes potatoes too!



THAT WAY Stand the Chefette on its 'nose', click in the liquidiser...for mixing drinks, chopping raw vegetables, blending patés, making breadcrumbs, grinding coffee.



PUT AWAY Dual purpose wall bracket is a fixed cradle for using the liquidiser and keeps your Chefette safely out of the way when not in use.



Kenwood kitchen!

For full information, and details of generous co-operative advertising terms, write to Dept. E.R.36.

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One of the Kenwood Group

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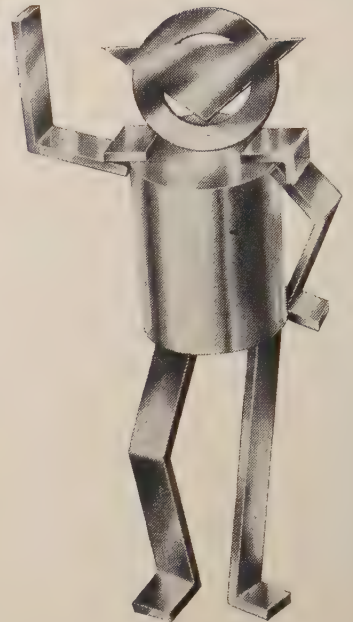
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Telephone: Widnes 2022. Telegrams: "Rolls", Widnes.

London Office & Export Sales Department: 168 Regent Street, London, W.1.
Tel: Regent 6427. Grams: "Wiredrawn, Piccy, London", (Overseas:) "Wiredrawn, London, W.1".



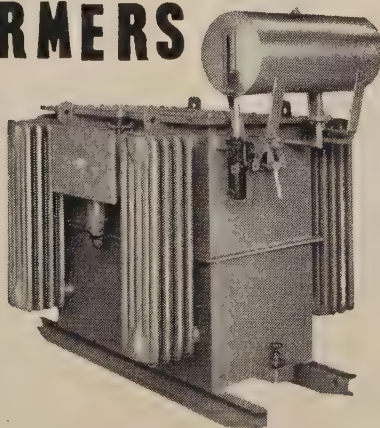
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ALL TYPES



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for "finger-tip" manual or automatic
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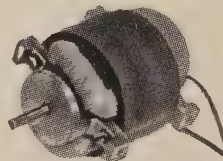
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shaded pole motors
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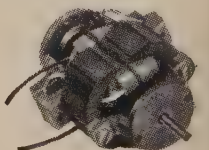


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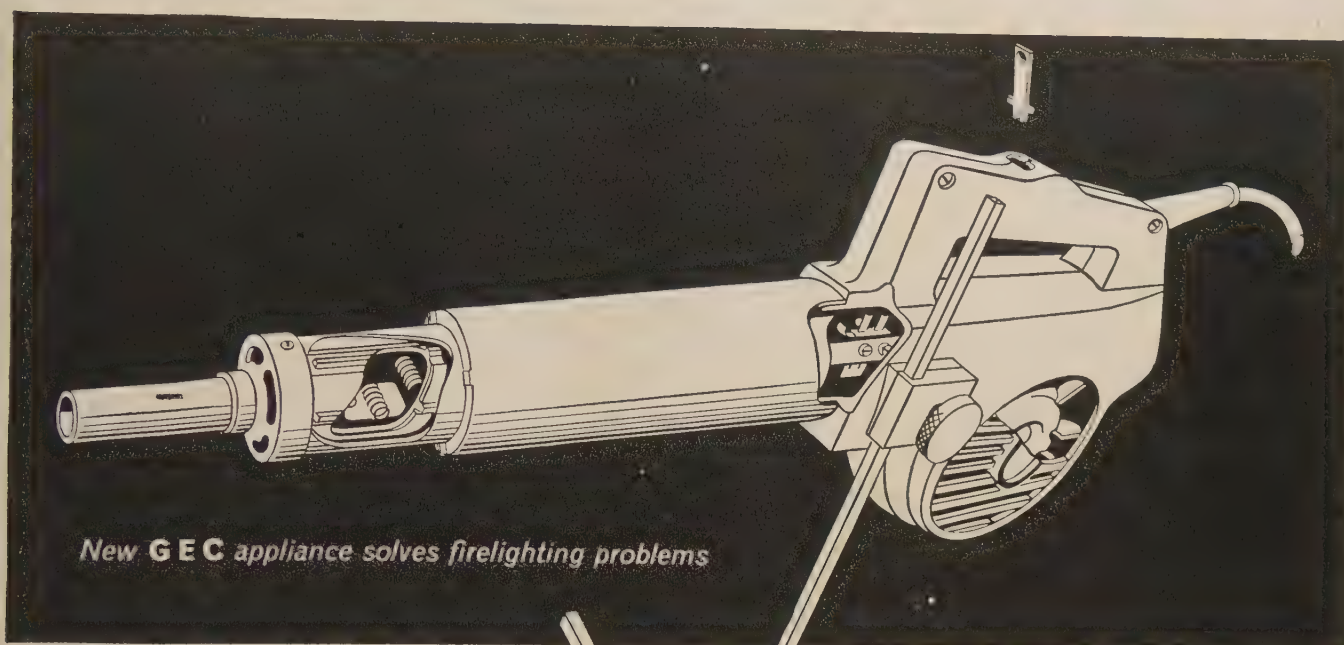
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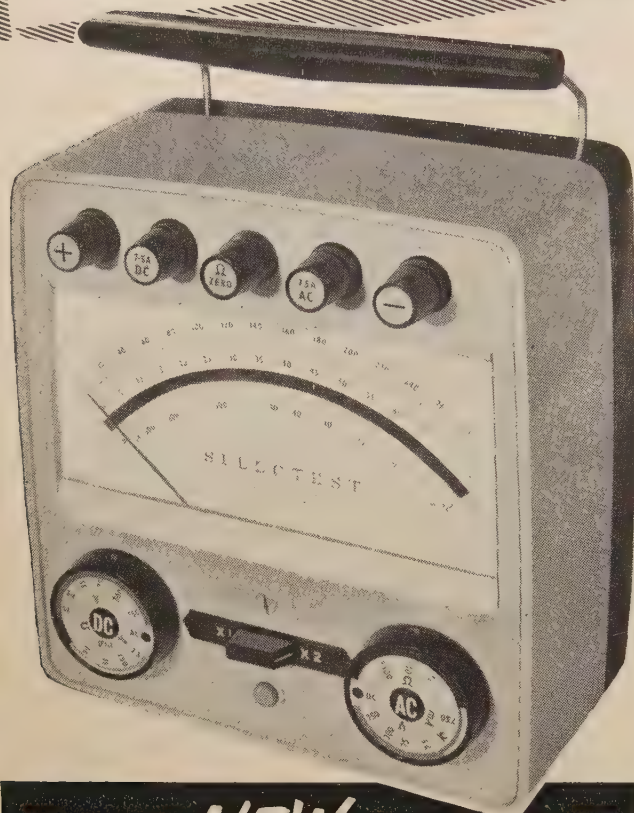
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MODEL SUPER K List price **£20 19 0**

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The resistors, rectifier, transformer, movement, switches and automatic cut-out are mounted on a robust printed circuit board, enclosed in a strong attractive, two-tone dustproof melamine case.

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Resistance

0—1000 ohms
0—10,000 ohms
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RANGES—Super 50

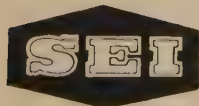
D.C. Volts—250mV to 2,500 V
D.C. Amps—50µA to 10A
A.C. Volts—2.5 V to 2,500 V
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Resistance

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Millions in service everywhere—Types X and CY in Cellulose Acetate or high grade P.V.C. Type NX (high duty) in high grade Nylon.



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of Simplex Lighting Equipment are shown here.

But we don't want just to sell you lighting fittings. We want to sell you light. The right amount of light in the right place at the right time. Therefore, we would be pleased to help or offer advice on any of your lighting problems—the type of fittings to use, the installation layout for best results etc. without obligation.

For immediate service there's a local Simplex branch near at hand—or write to Lighting Dept., at the head office address below.

SIMPLEX PRODUCE LIGHTING TAILORED TO EVERY REQUIREMENT ... INCLUDING YOURS

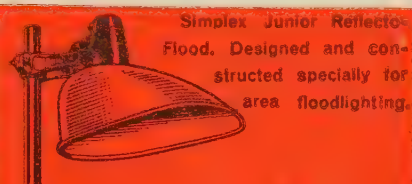
Simplex

SIMPLEX ELECTRIC COMPANY LIMITED
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ELECTRICAL DIVISION

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Simplex Junior Reflector Flood. Designed and constructed specially for area floodlighting.

Simplex Dispersive Range of Weather-proof Reflectors for interior and exterior uses.

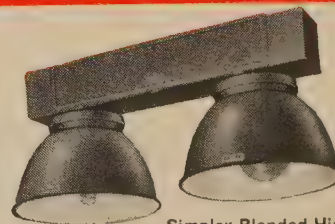


Simplex Bulkhead Fittings. A range of general purpose fittings of exceptional strength.

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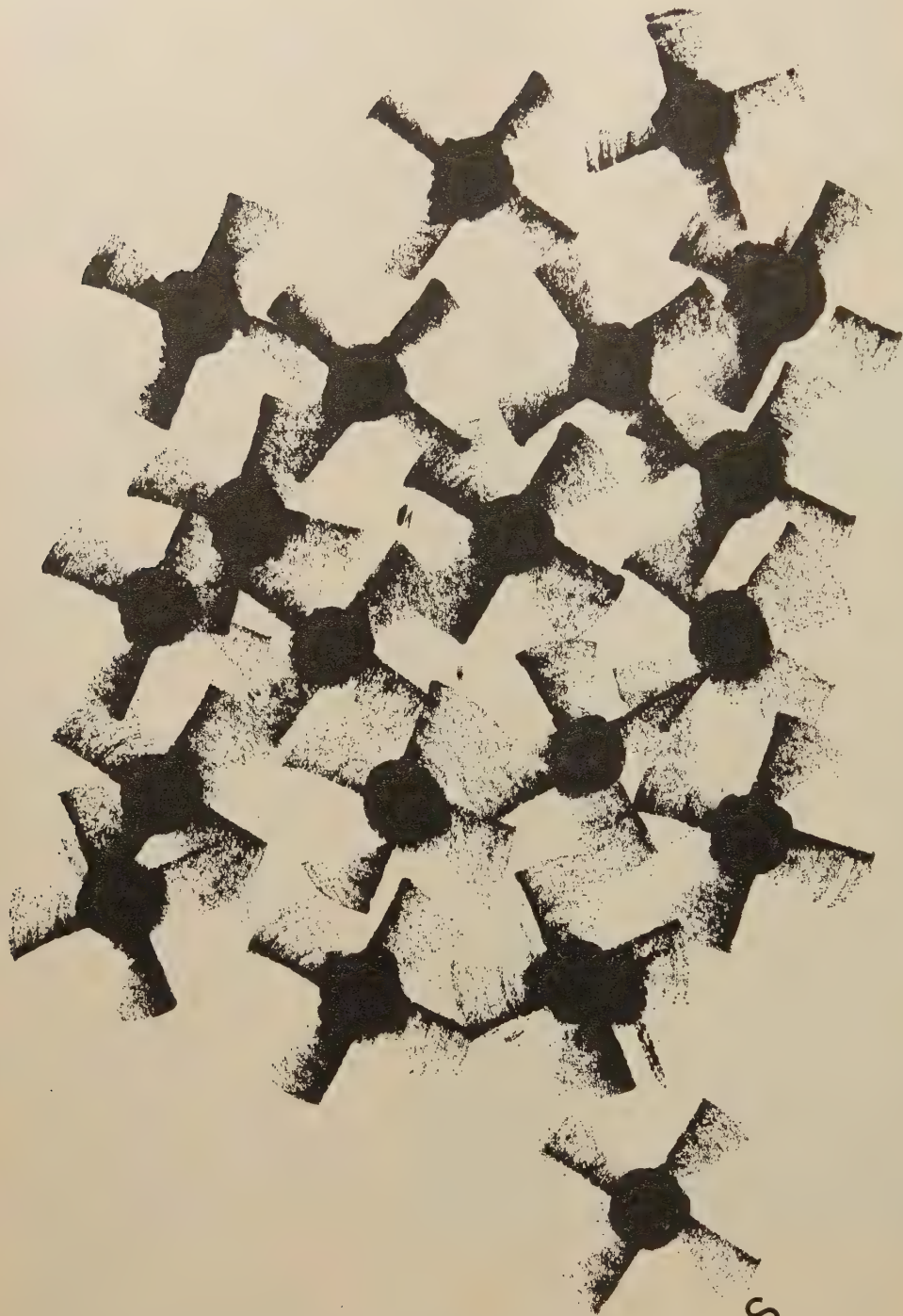
The Simplex ACF (anti-corrosion fluorescent) Fittings are protected by a patented process that will not corrode even in the heaviest of industrial atmospheres.



Simplex Blended High-Bay Fittings for interior installation where a blend of mercury and tungsten light is required.

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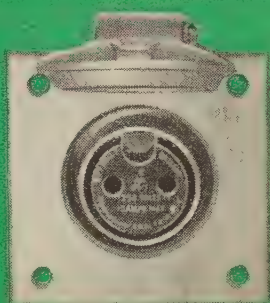
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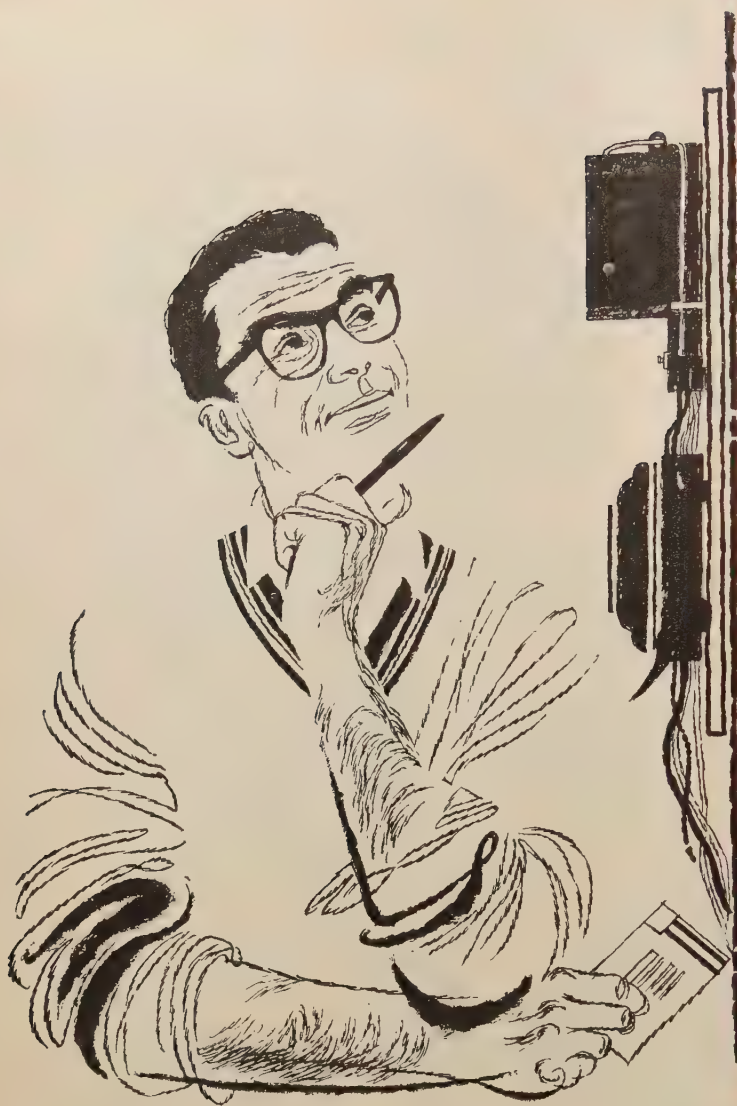
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Ferranti, in a word, make the best meters—and more of them, for home and export markets. Meters the size of filing cabinets, meters no bigger than a box-camera. Meters that hide in cupboards; giant summation meters for great power projects like the Kariba Dam; meters for the National Grid. Currently Ferranti are spending £200,000 on new meter plant installations aimed to increase out-put by 30%. And always, the experts at Ferranti are working to increase efficiency and cut costs.

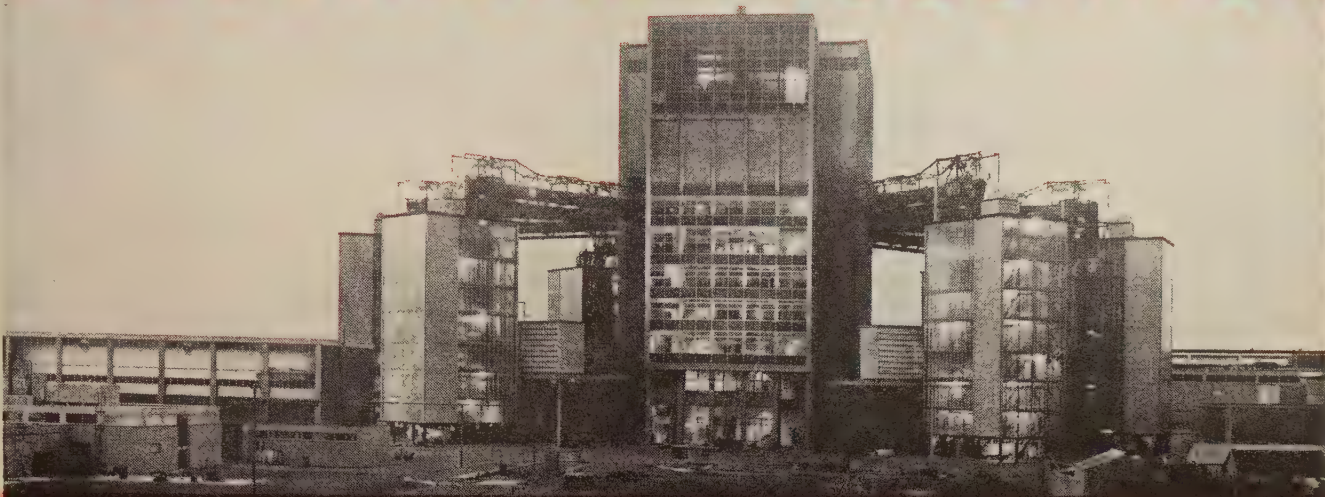
Like Ferranti meters, Ferranti electrical and electronic products are to be found all over the world—in engineering, the aircraft industry, scientific and business organisations. And everywhere, in all their uses, they are leading the way to a better life.

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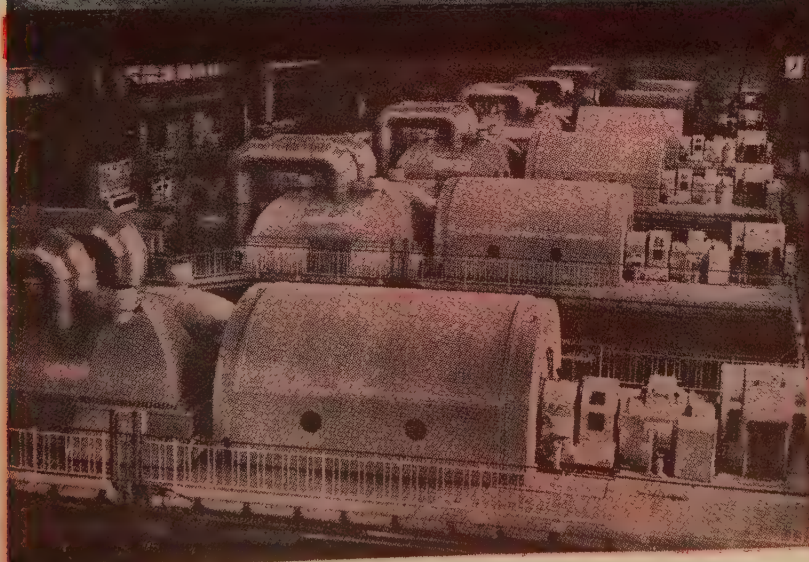
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for Nuclear Power Stations



The first two C.E.G.B. Nuclear Power Stations both make extensive use of M&I insulation; in the electrical plant supplied by AEI to Berkeley and by C. A. Parsons & Co. Ltd., to Bradwell. Amongst the various types of insulation supplied are "Paxolin" tubes, transformer cylinders and fabric based material as well as Micanite in various forms including V-rings.

As the manufacturers of the most extensive range of electrical insulating materials in this Country M & I naturally have a wide experience of insulation problems on every type of power generation and distribution system.



the electrical insulation people

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Grams: Mytilite, London, Telex. Telex 25183

Photographs by courtesy of The Nuclear Power Group.
Bottom picture shows the six Parsons 52MW turbo-generators in which M & I Micanite V-rings have been used.

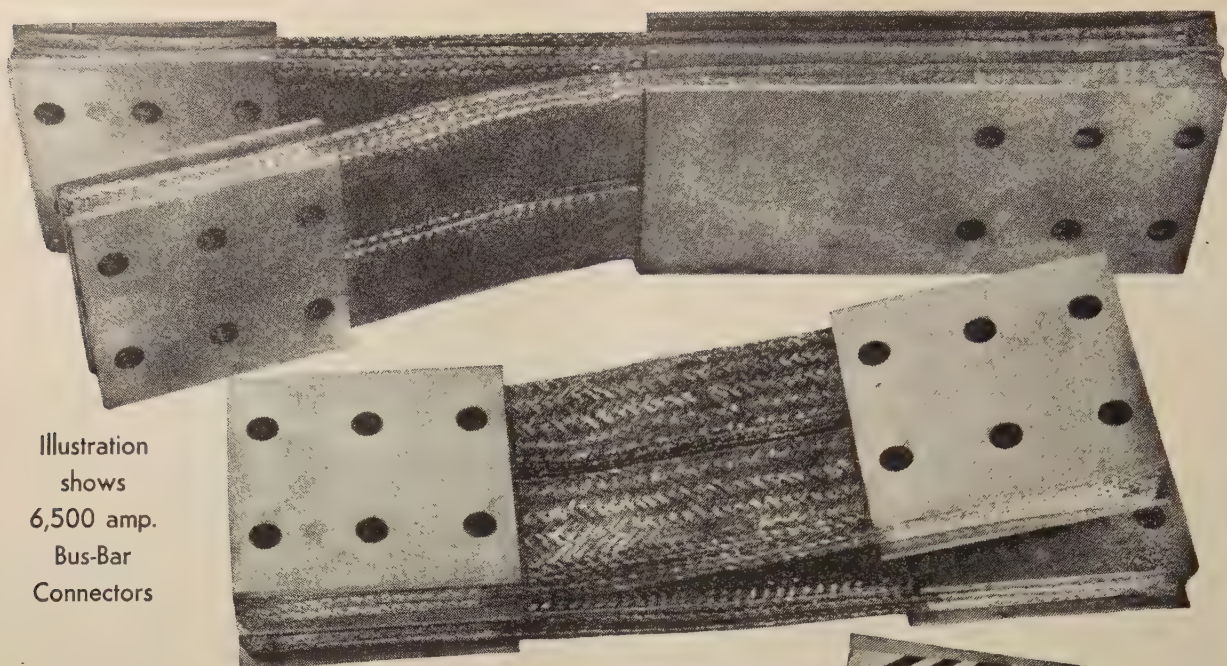


Illustration
shows
6,500 amp.
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SAXONIA ELECTRICAL WIRE Co. Ltd.

*over 65 years specialist
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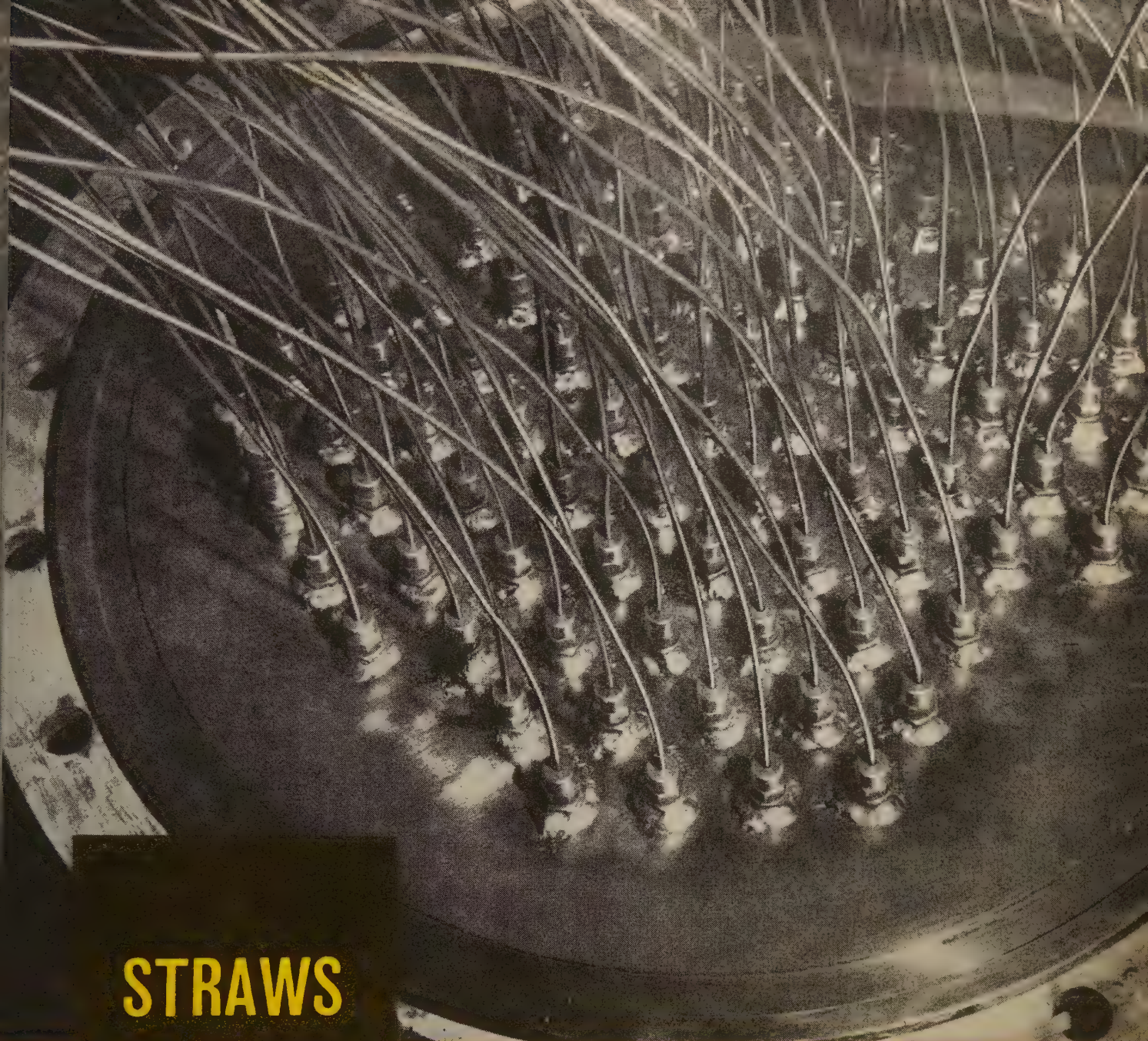
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BRITISH RAILWAYS



STRAWS IN THE WIND?

...Yes, indeed, a nuclear precedent for industry

The photograph shows a close-up of one of the seal glands on the pressure vessel wall and biological shield at Berkeley Power Station through which pass some of the 982 "Pyrotенax" thermocouple cables. It is printed by courtesy of A.E.I.—John Thompson Nuclear Energy Company Limited, a Partner Company of The Nuclear Power Group.

The almost automatic choice of "Pyrotенax" thermocouples and compensating cables for the requirements of nuclear power set a precedent for industry—and one which has been quickly followed. Industrial applications are increasing every month.

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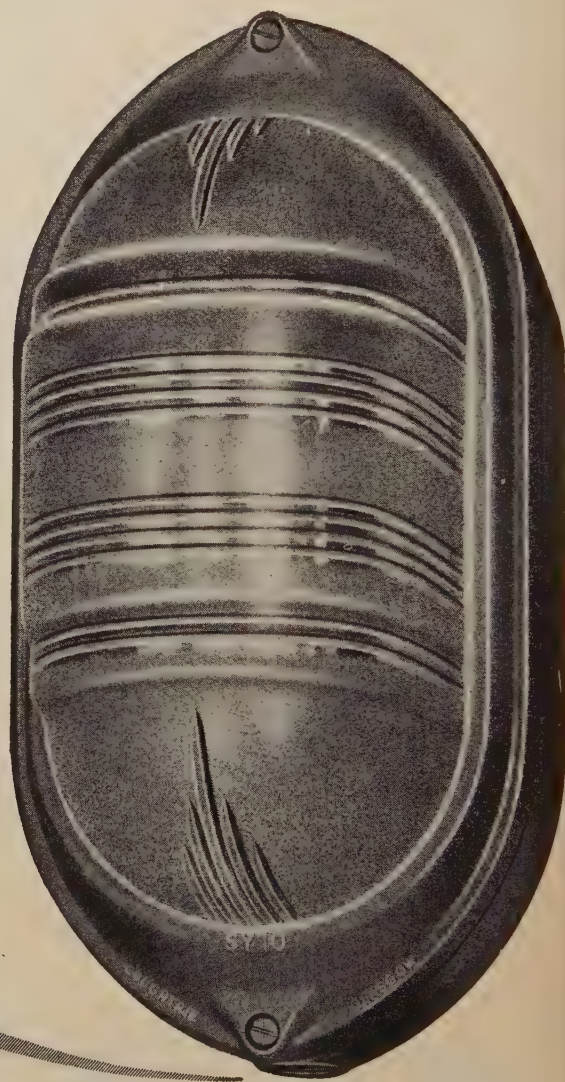
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60 watt



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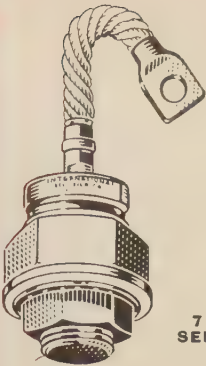
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Code	Rated P.I.V.* Volts	Maximum Rectified Forward Current		Max. Peak Surge Current (sinusoidal) 10mS at Working Temp. Amps.	Typical Forward Volt Drop over Conducting Period Volts.
70U SERIES 70 TO 250 AMP.					
		Convection Cooled Amps.	Fan Cooled at 1000 L.F.M. Amps.		
70U5	50	110	220	2000	1.05
70U10	100	110	220	2000	1.05
70U20	200	110	220	2000	1.05
70U40	400	110	220	2000	1.05
70U60	600	110	220	2000	1.05
70U80	800	110	220	2000	1.05
RATING NOTES: *Maximum peak voltage which must cater for peak of crest plus any transients in the system †Single phase halfwave rating, mounted on 7" x 7" by 0.160" thick fin, at 30°C Ambient					
45L SERIES 45 TO 150 AMP.					
45L5	50	58	130	1500	1.05
45L10	100	58	130	1500	1.05
45L20	200	58	130	1500	1.05
45L40	400	58	130	1500	1.05
45L60	600	58	130	1500	1.05
45L80	800	58	130	1500	1.05
45L100	1000	58	130	1500	1.05
RATING NOTES: *Maximum peak voltage which must cater for peak of crest plus any transients in the system †Single phase halfwave rating, mounted on 5" x 5" by 0.1" thick fin, at 30°C Ambient					
25H SERIES 25 TO 45 AMP.					
25H5	50	20	55	400	1.05
25H10	100	20	55	400	1.05
25H20	200	20	55	400	1.05
25H40	400	20	55	400	1.05
25H60	600	20	55	400	1.05
RATING NOTES: *Maximum peak voltage which must cater for peak of crest plus any transients in the system †Single phase halfwave rating, mounted on 3" x 3" by 1/8" thick fin, at 30°C Ambient					



70U SERIES



45L SERIES



25H SERIES

HIGH POWER 25 to 250 amps

Code	Rated P.I.V.* Volts	Maximum Rectified Forward Current		Max. Peak Surge Current (sinusoidal) 10mS at Working Temp. Amps.	Typical Forward Volt Drop over Conducting Period Volts.
25HB SERIES 25 TO 35 AMP.					
		Convection Cooled Amps.	Fan cooled at 1000 I.F.M. Amps.		
25HB5	50	20	53	300	1.05
25HB10	100	20	53	300	1.05
25HB20	200	20	53	300	1.05
25HB40	400	20	53	300	1.05
25HB60	600	20	53	300	1.05
25HB80	800	20	53	300	1.05
RATING NOTES: *Maximum peak voltage which must cater for peak of crest plus any transients in the system †Single phase halfwave rating mounted on 3" x3" by 1/8" thick fin, at 30°C Ambient					

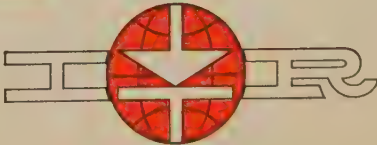


25HB SERIES

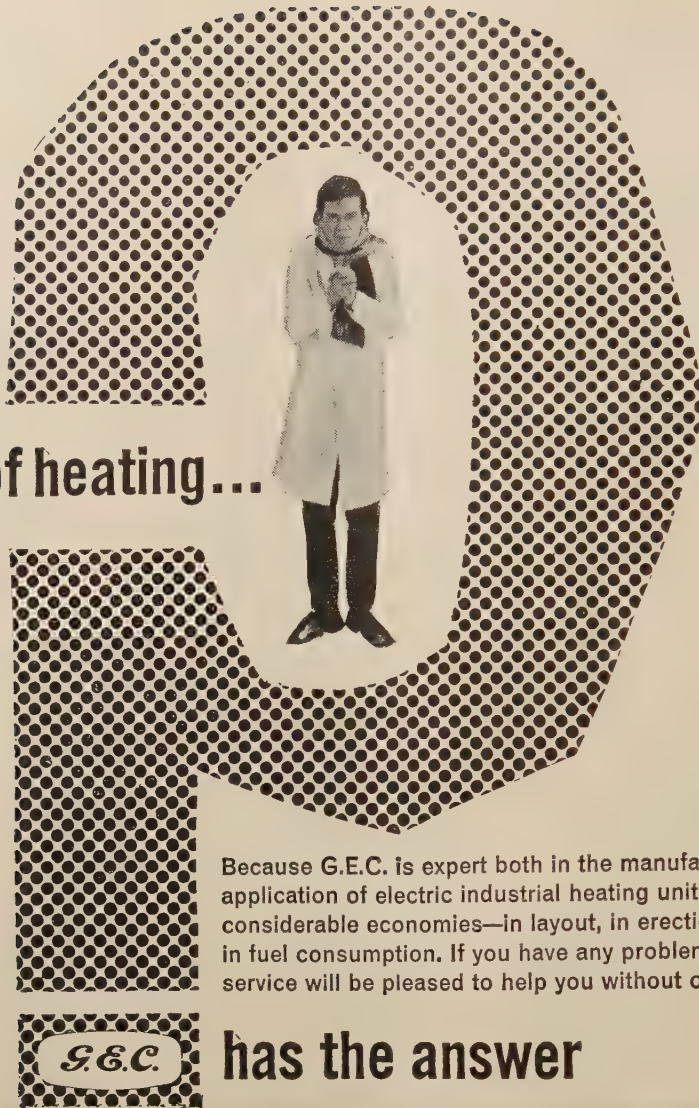
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Instant glowing warmth where overall air heating would be too costly. Adjustable reflectors give concentrated or widespread beam.

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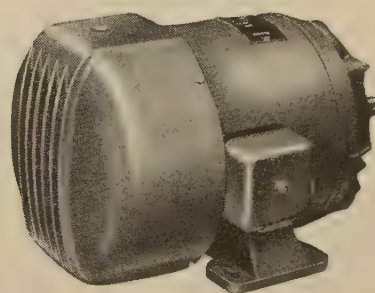
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INDUSTRIAL HEATING DIVISION THE GENERAL ELECTRIC COMPANY LIMITED MAGNET HOUSE KINGSWAY LONDON WC2



— but for fractional horse-power in industry...

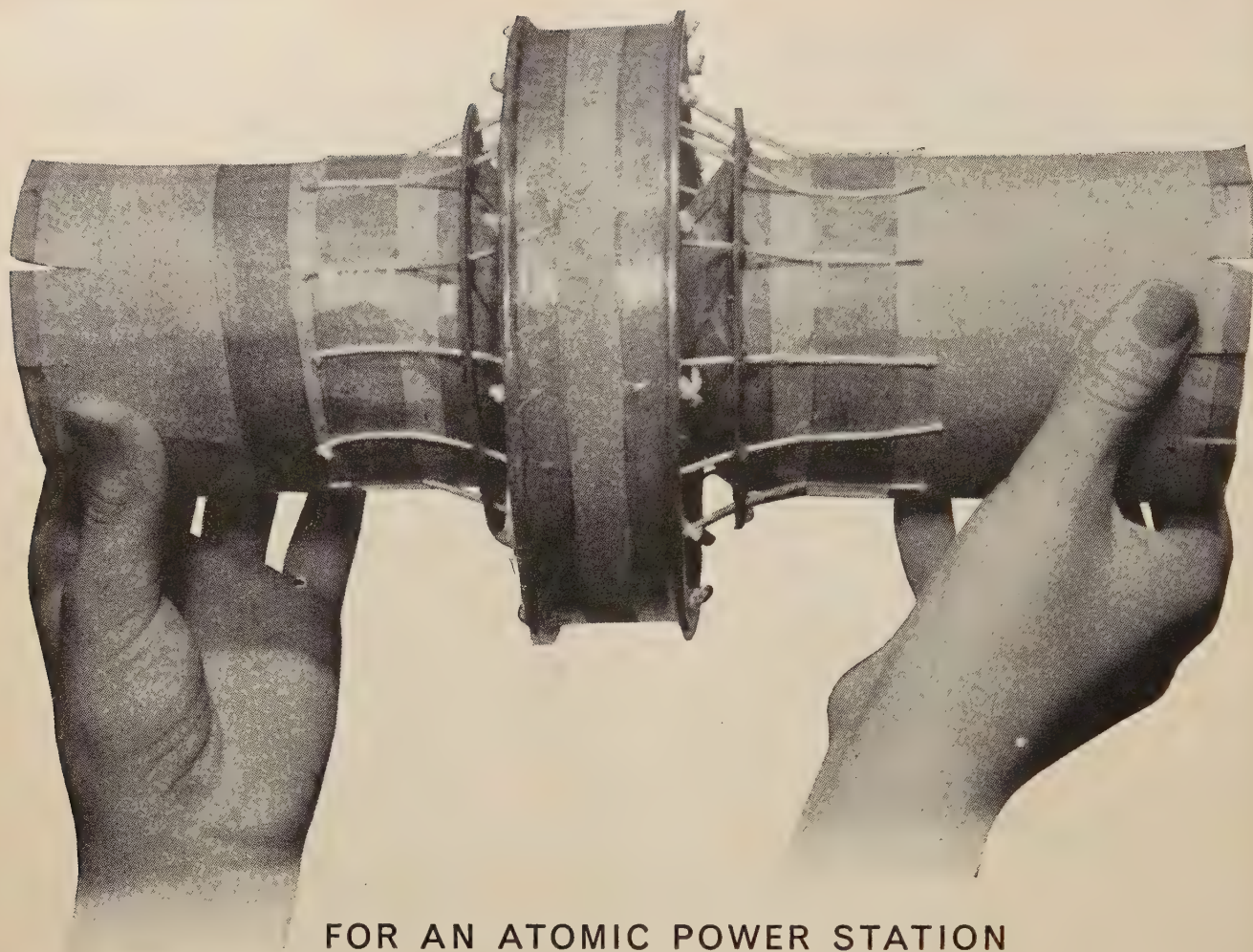
wherever and whatever the duty, 'ENGLISH ELECTRIC' f.h.p. motors can be put to work with efficiency and economy. These sturdy motors are built to give good service under the most arduous conditions. The right f.h.p. motor for your job, from 1/20 h.p. upwards, is in the 'ENGLISH ELECTRIC' range.



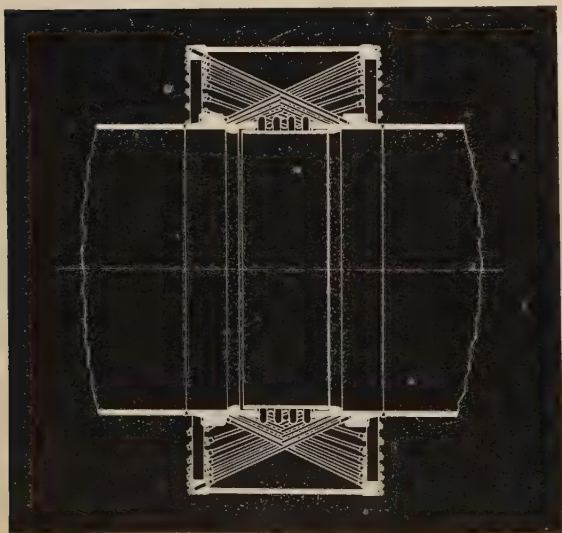
'ENGLISH ELECTRIC'

f.h.p. motors

F.H.P. MOTORS DEPARTMENT, PHOENIX WORKS, BRADFORD
The English Electric Company Limited, English Electric House, Strand, London, W.C.2.



FOR AN ATOMIC POWER STATION



Don't despair if you cannot immediately follow the functioning of the bar system. It took the Engineering Division several days to understand it, and the only way they could make it clear to our executives was with the cardboard model in the photograph.

With cardboard, string, the office sticky-tape and an artificial pearl borrowed from a typist (for the spherical joint between the two cones) Richardsons Westgarth engineers have knocked up a radically new solution to a very old and tricky problem – how to take up the expansion of large pipes carrying high pressures. The problem came into the design office in the specific form of the CO₂ ducting of the Trawsfynydd Atomic Power Station. Pressure 265 p.s.i.; temperature 420°C; axial thrust on any cross section over 1,000,000 lb.

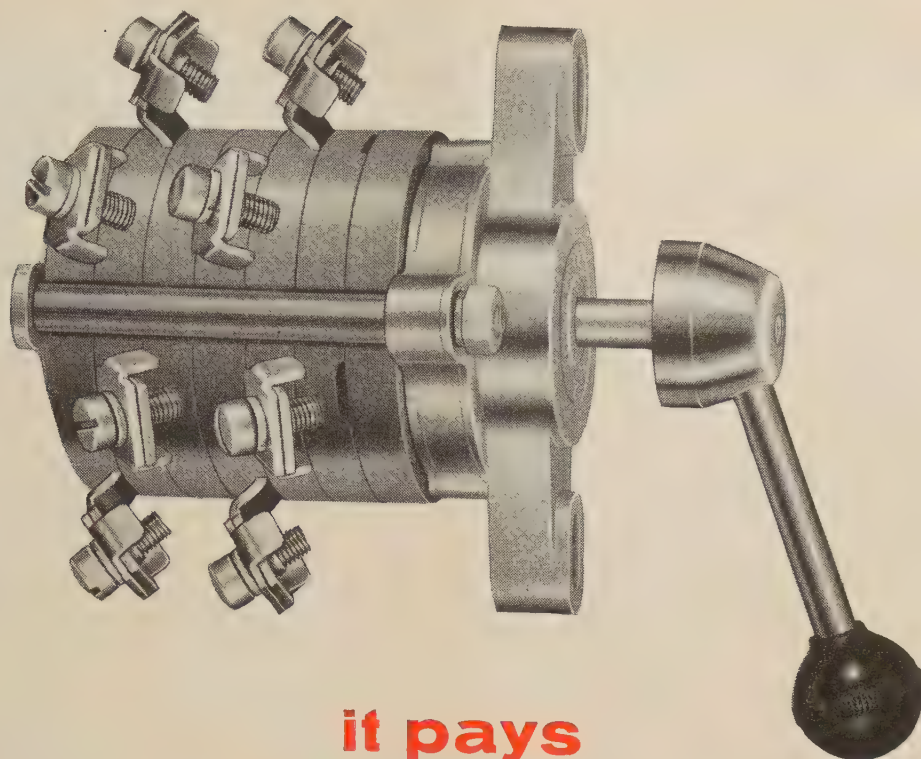
The usual means of taking this thrust – on either an internal flexible tongue or an external arrangement of hinge pins, guides and rollers – are cumbersome and, worse, flexible in only one plane, so that any sideways deflection produces stresses incapable of analysis. Rollers and pins need lubrication and are subject to wear, and both disturb the uniform distribution of stress around the periphery of the pipe. In the new Richardsons Westgarth joint the end restraint is provided by a ring of high-tensile steel bars, and flexing is taken entirely by elastic stress in these bars. The joint is thus flexible in *all* directions. No lubrication is needed; all forces are calculable – and they are fed uniformly onto the periphery of the restraint.

This is the kind of solution – unconventional, simpler, sounder and cheaper – that the fresh thinking of Richardsons Westgarth engineers is continually producing.

RICHARDSONS, WESTGARTH & CO LTD



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to switch
to

ARROW

multi-circuit switches

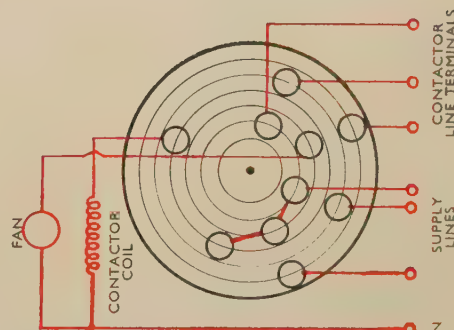
Ratings 10 to 200 amps up to 600 volts AC or DC

Minimum panel space required

Of robust construction and approved design

Delivery is assured within a few days

Write or telephone TODAY for full information



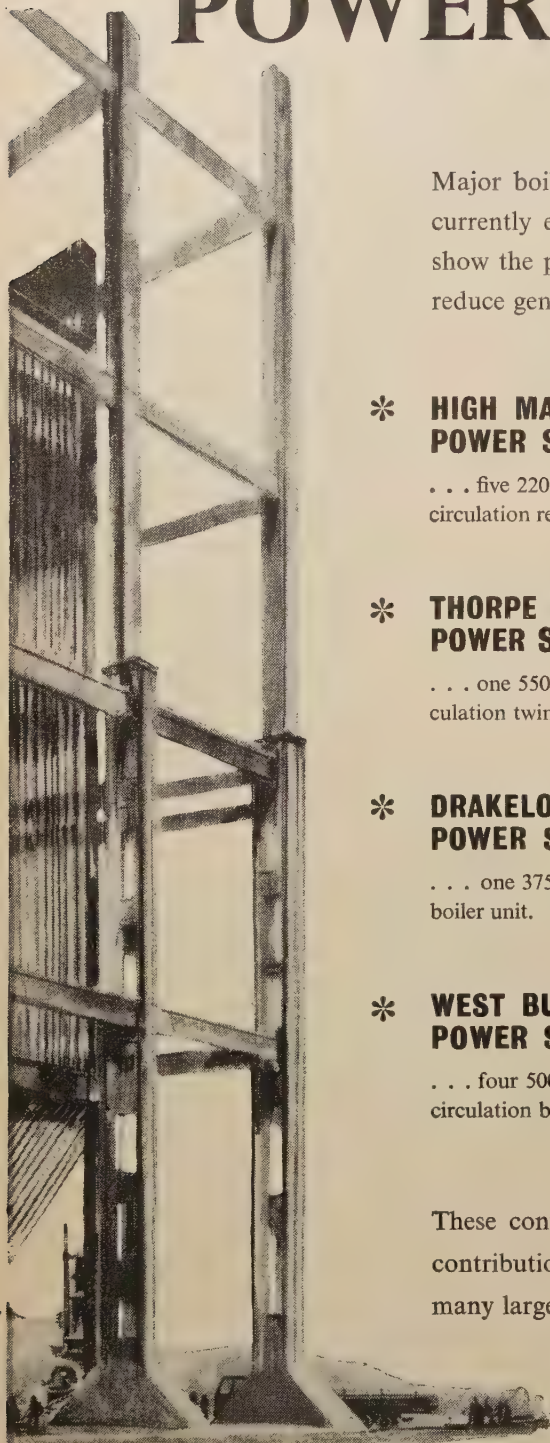
Simultaneous switching of various circuits saves space.

ARROW Electric Switches Ltd

Brent Road
Southall
Middlesex

Telephone: Southall 2442

PROGRESS IN POWER PLANT DESIGN



Major boiler contracts in which International Combustion Limited are currently engaged for the Central Electricity Generating Board, clearly show the pattern of development adopted to achieve greater output and reduce generating costs.

* **HIGH MARNHAM
POWER STATION**

. . . five 220 MW controlled circulation re-heat boiler units.

EVAPORATION	STEAM TEMPERATURE
1,400,000 lb/hr	1,060°F
STEAM PRESSURE	RE-HEAT TEMPERATURE
2,450 lb per sq. in.	1,005°F

* **THORPE MARSH
POWER STATION**

. . . one 550 MW controlled circulation twin furnace boiler unit.

EVAPORATION	STEAM TEMPERATURE
3,750,000 lb/hr	1,055°F
STEAM PRESSURE	RE-HEAT TEMPERATURE
2,400 lb per sq. in.	1,055°F

* **DRAKELOW 'C'
POWER STATION**

. . . one 375MW super-critical boiler unit.

EVAPORATION	STEAM TEMPERATURE
2,500,000 lb/hr	1,110°F
STEAM PRESSURE	RE-HEAT TEMPERATURE
3,650 lb per sq. in.	1,055°F

* **WEST BURTON
POWER STATION**

. . . four 500 MW re-heat controlled circulation boiler units.

EVAPORATION	STEAM TEMPERATURE
3,450,000 lb/hr	1,055°F
STEAM PRESSURE	RE-HEAT TEMPERATURE
2,400 lb per sq. in.	1,055°F

These contracts are significant stages in the International Combustion contribution to power supply in Great Britain, and are supported by many large overseas contracts and for nuclear power plant.

IC

INTERNATIONAL COMBUSTION LIMITED

NINETEEN WOBURN PLACE, LONDON, W.C.1. TELEPHONE TERMINUS 2833
WORKS: DERBY

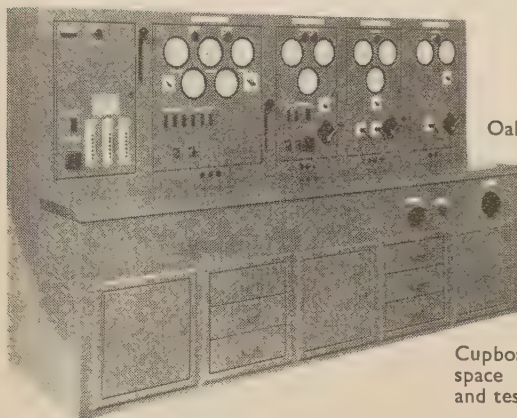
*Another of
our specials*

ELECTRICAL AND REMOTE CONTROL EQUIPMENT

*Tailor made to YOUR
specification
or engineered
and designed for YOU*

Panel suitable for testing A.C.
and D.C. Equipment of varying
voltage and load

Front access to
all compartments
by means of
doors inter-
locked with sec-
tional isolators



Oak bench top

Cupboard and draw
space for instruments
and test records

CONTROL PANEL FOR TEST ROOM



The Mark of the Specialist

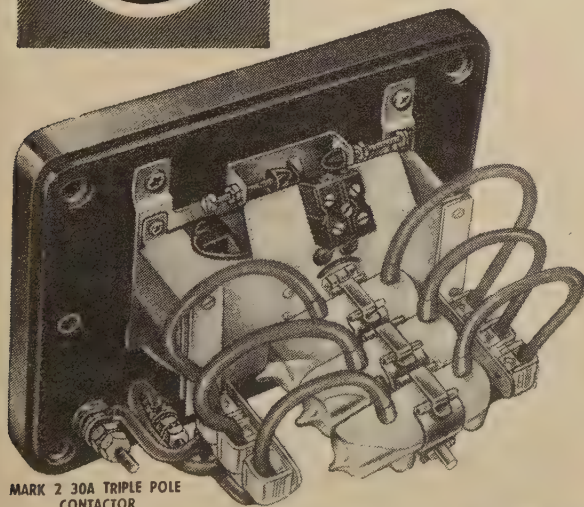
Field & Grant LTD.

KENT STREET • BIRMINGHAM 5

Phones: MIDLAND 8574-5-6 LONDON, HARROW 5578 SHEFFIELD 345967

FOR YEARS OF RELIABLE SERVICE CHOOSE

RELAYS & CONTACTORS



MARK 2 30A TRIPLE POLE
CONTACTOR

We specialise in the manufacture of vital com-
ponents for use in the automatic electrical
control gear field.

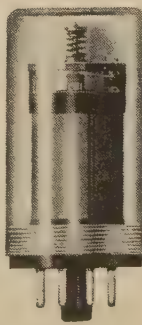
The relays and contactors illustrated are typical
of the wide range of units manufactured for con-
trol purposes.

Relays of the tilting mercury switch type are
manufactured in sizes up to 200 amp. triple pole
and in encapsulated pattern up to 30 amp. triple
pole.

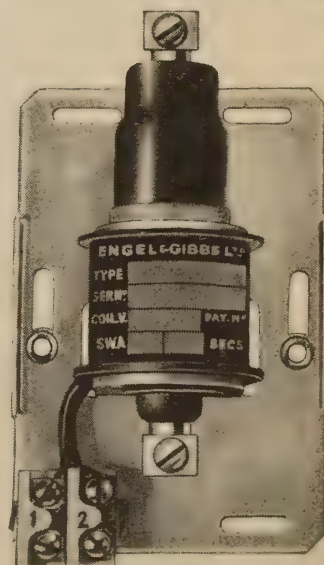
Metallic contact relays
are available in plug-in
version with contact
ratings of 3 amp. 240v.
A.C. double pole change-
over arrangement.

In addition to relays and
contactors we manufacture
a series of Temperature
Sensitive Switches and are always
pleased to quote for control
panels of all types.

PLEASE WRITE FOR
FULL DETAILS -



PLUG-IN RELAY



METAL MERCURY SWITCH ENCAPSULATED RELAY
NEW PRODUCT

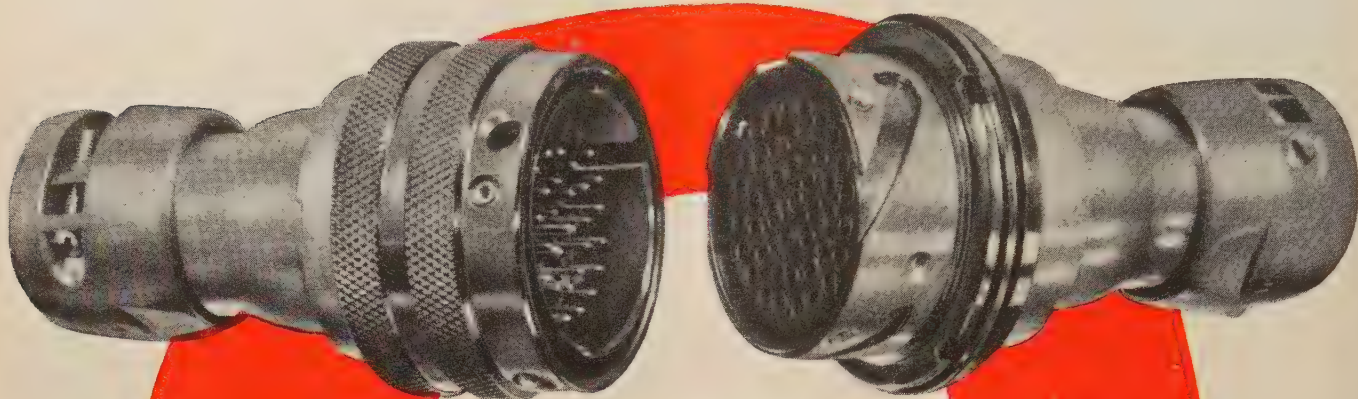


ENGEL & GIBBS LIMITED

ELSTREE WAY BOREHAM WOOD HERTS. Phone: ELSTREE 2291/4

Plessey**MARK 6**

A new conception in high performance connectors
with 6 outstanding features *



- * Crimped connections
- * -55°c to + 155°c
- * Bayonet Coupling
- * 6 to 55 contacts
- * Pressure sealed
- * 1kV. all contacts

The new Plessey Aluminium Mark 6 is an entirely new conception in electrical connectors—offering a greater number of contacts than the ubiquitous Mark 4 plus other singular features introduced to meet the exacting requirements of this modern age.

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To all users of electrical connectors, the Plessey Mark 6 Connector constitutes the latest example of forward-thinking design and unsurpassed efficiency from a Company recognised throughout the world as one of the leading manufacturers of high quality, reliable electrical connectors.

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THE PLESSEY COMPANY LIMITED • CHENEY MANOR • SWINDON • WILTS • SWINDON 6251

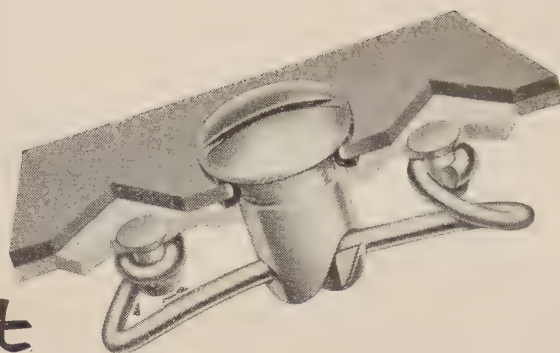
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DZUS

the most efficient

FASTENING

for the Electrical Industry



- DZUS lock or unlock instantly in a simple quarter-turn
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DZUS Fasteners offer the most effective, most efficient, and *quickest* form of fastening for scores of vital uses in Electrical development.

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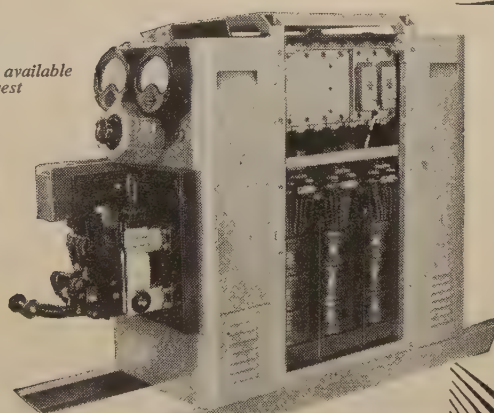
DZUS FASTENER EUROPE LTD • FARNHAM FACTORY ESTATE • GUILDFORD ROAD • FARNHAM • SURREY

SELENIUM & SILICON RECTIFIERS

FOR DC
POWER
SUPPLIES

Illustrated is a 30 V. 2,000 amp. air cooled rectifier with Remote Control which has a range of 200/2,000 amps. Units of this order can be supplied as straight Transformer Rectifiers or with Magnetic Amplifier Control giving smooth D.C. Control outputs over a wide range. Air Blast or Oil Filled can be supplied depending upon the application and use.

Leaflet available on request

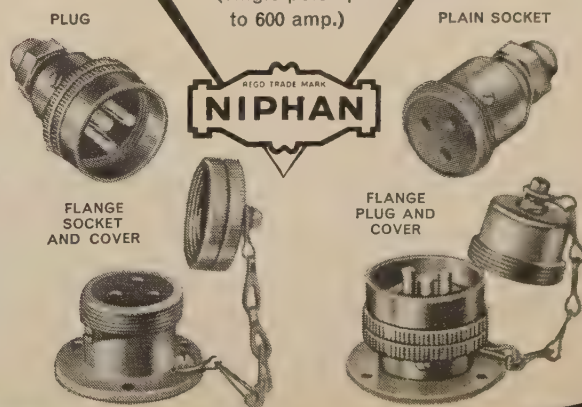


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GATWICK ROAD, CRAWLEY, SUSSEX

WEATHERPROOF METAL-CLAD

PLUGS & SOCKETS

5-300 amp. 250-500 volt.
(single pole up to 600 amp.)



SIMMONDS & STOKES (NIPHAN) LTD

MANUFACTURING ELECTRICAL ENGINEERS

Victoria House, Southampton Row, London, W.C.1. HOLborn 2163, 8637

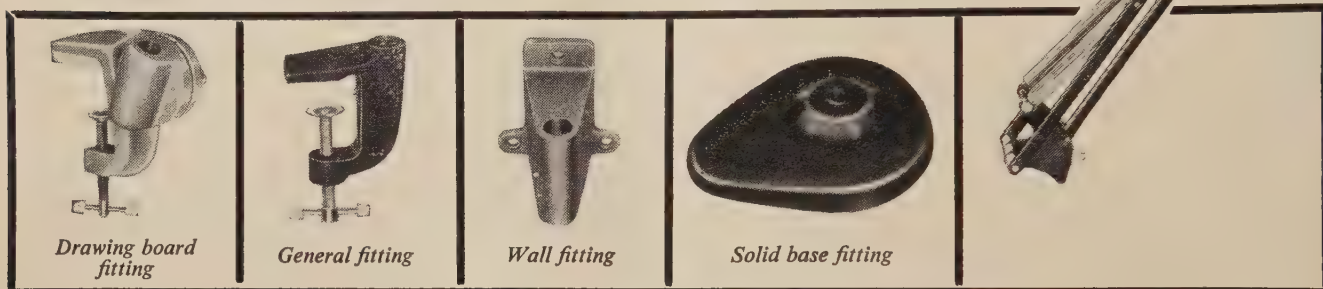
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The ingenious spring arrangements and

A NEW ANGLE ON LAMPS

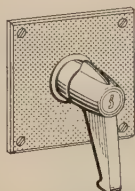
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Telephone: WATerloo 6056 & 2166-7

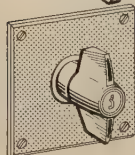


A 'WASO' PRODUCT: 39 HERTFORD STREET, LONDON, W.1

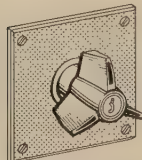
**PISTOL
GRIP**



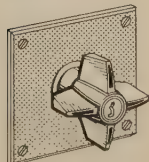
SPADE



STAR



CRUCIFORM



These new shapes are now available to all users

Trawsfynydd, the latest of Britain's nuclear power stations, will incorporate more than 2,500 Austinlite rotary control switches. They are designed to meet the exacting requirements of the Central Electricity Generating Board and of the main contractors, Atomic Power Constructors Limited.

Modern power station practice demands that switch duties be identified by the shape of the operating handle. To meet this requirement Austinlite produced these special designs.



(Artist's impression of Trawsfynydd by courtesy of C.E.G.B.)

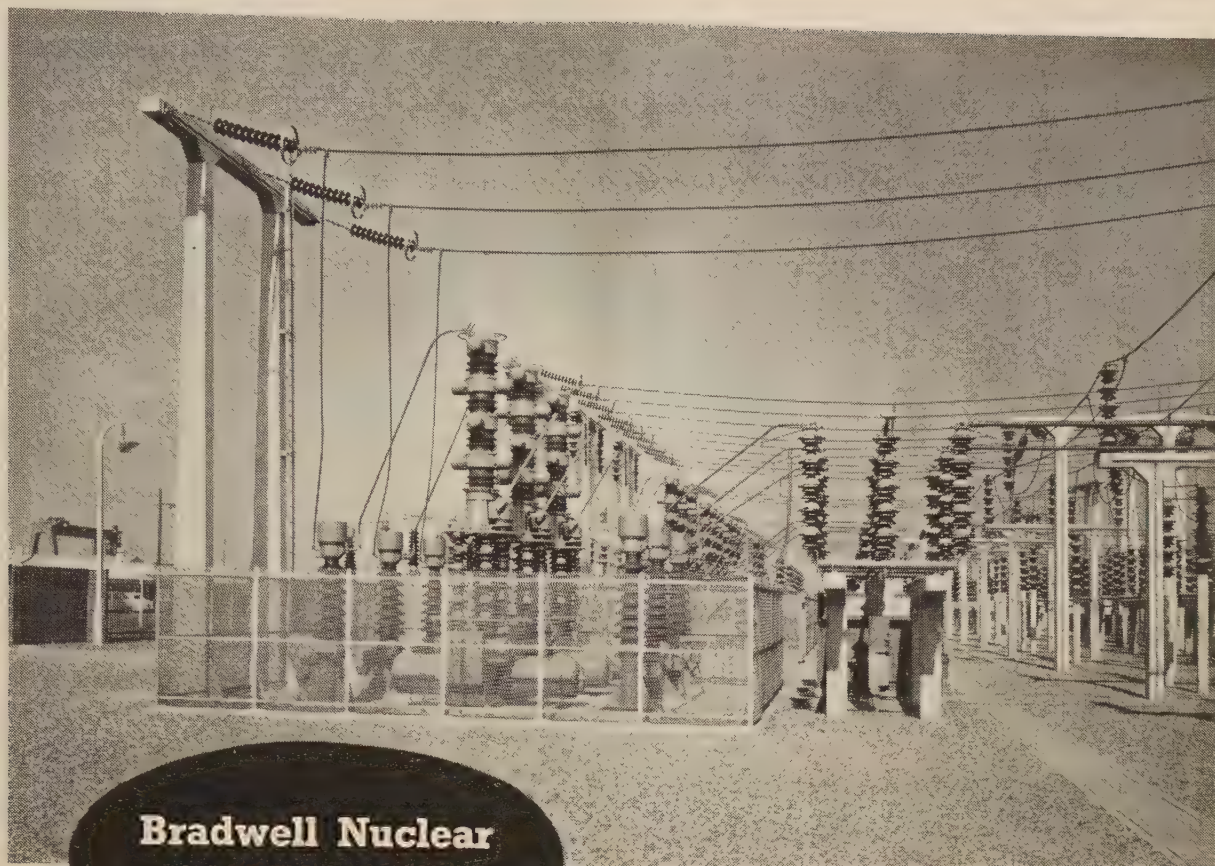
Austinlite

**ROTARY
SWITCHES**

• custom-built by Stone-Chance Limited

ENQUIRIES:

To help us to give prompt service, enquiries should now be addressed to Austinlite Limited, Pickersleigh Road, Malvern, Worcs., or to the London Office:- Schomberg House, 82 Pall Mall, S.W.1.



**Bradwell Nuclear
Power Station**

Photograph by courtesy of the C.E.G.B. South Eastern Region

A section of the 132-kV switching station at Bradwell equipped with Reyrolle 3,500-MVA air-blast circuit-breakers.

Reyrolle also supplied through The Nuclear Power Group:

6.6-kV, 3.3-kV, and 415-volt air-break
switchgear for station auxiliaries

Remote-control equipment for the
switchgear and the reactors

Control-rod heads for the reactors

Burst-slug detection equipment

Stand-by supply equipment



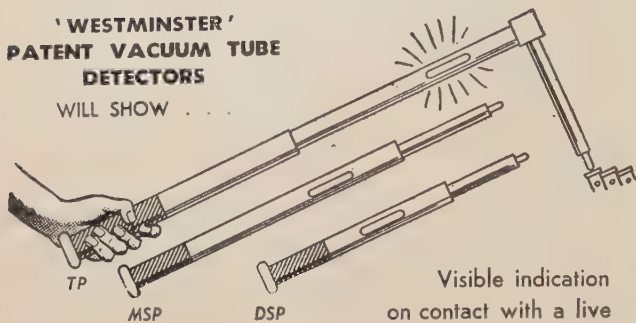
Reyrolle

MEMBER OF THE NUCLEAR POWER GROUP

A. REYROLLE & COMPANY LIMITED • HEBBURN • COUNTY DURHAM • ENGLAND

Is It Alive?

'WESTMINSTER'
PATENT VACUUM TUBE
DETECTORS
WILL SHOW . . .



RANGE 2,000 to 35,000V

Visible indication
on contact with a live
conductor, or in the case
of high voltage as soon
as Detector approaches
and before contact is made.

Made by the manufacturers of Westminster Phasing devices
and Partridge HV Detectors

Write for full particulars to:-

The WESTMINSTER ENGINEERING Co Ltd

(Dept. H.1) Victoria Road, Willesden Junction, London NW10

Telephone: ELGar 7372 (2 lines)

FIRST AID

Pioneers in Industrial First Aid well over half-a-century ago, before legislation for this was introduced, we have a wealth of experience and knowledge available to you when considering the provision of First Aid.

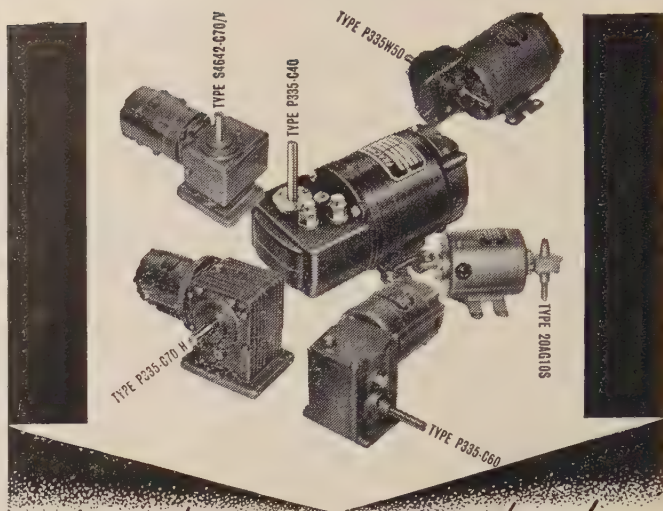
On January 1st 1960, revised First Aid regulations (S.I. 1959 No. 906) became operative, affecting most factories.

Ensure that you are complying with the latest regulations by consulting us for all your First Aid requirements.



Conforming to the requirements of S.I. 1959 No. 906 for factories in which the number of persons employed exceeds ten but does not exceed fifty.

A PRODUCT OF *Cuxson, Gerrard & Co. Ltd.* OLDBURY BIRMINGHAM



*Your Motor problem is already
solved by*

FRACMO MOTORS

Models illustrated are just a few geared units from our vast range, providing output speeds from 0.125 r.p.m. to 590 r.p.m. against torque loadings from a few ozs/ins. up to 350 lb/ins.

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Agents:
Law & Plumtree, Dale Bldgs., Dale Rd., Matlock, Derbyshire. Tel.: Matlock 326
P. A. Bennett, 29 Hollins Drive, Sheffield, 6. Tel.: Sheffield 345967

DaF 171161 ER

NEW!!

15-WAY ROTARY SWITCH

Adjustable from 1 to 15 way

**THE SWITCH for
Transformer Tapping Control**

15 amp — 30 amp
S.P. — D.P. — T.P.

Phone: Kings Norton 1604



HENLEY BURROWES & CO. LTD.

Factory Centre KINGS NORTON, BIRMINGHAM

RELAY USERS

"CORREX" TENSION GAUGES

The only instrument solely designed for accurately measuring tension on Relays, Contacts, Switchgear, and electrical apparatus of all kinds. Gauge measures in grammes, and a large range of sizes is produced to cover from 0.3-2,000 grammes.

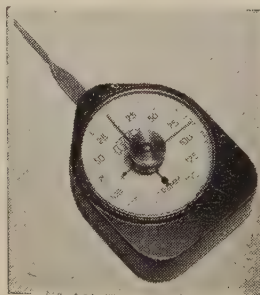
Swiss made and guaranteed.

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JAMES W. CARR & CO. LTD.

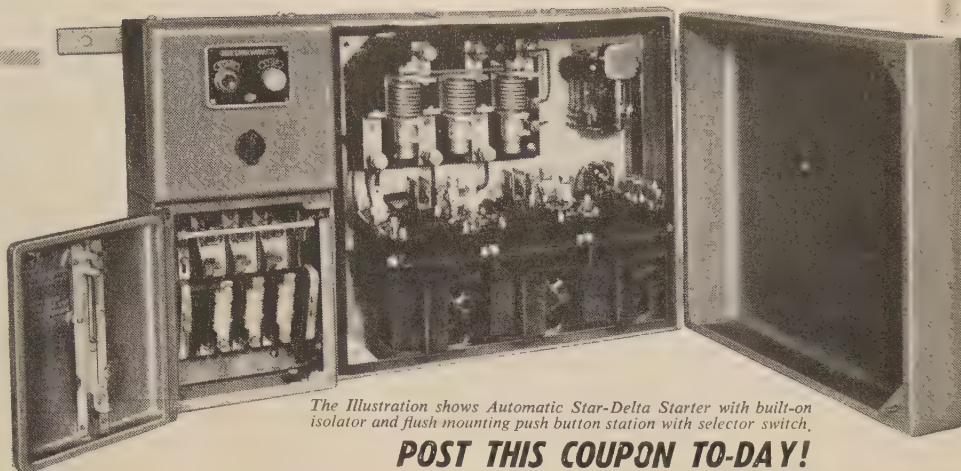
Dept. SALES, 7-15, Rosebery Avenue, LONDON, E.C.1

Telephone: TERMINUS 8866 (P.B.X.)



B K S**AUTOMATIC STAR-DELTA STARTERS**

This range of automatic star-delta starters is suitable for controlling motors up to 55 h.p. on 380/440 volts, three-phase supply, and utilised in their construction are our now famous heavy duty contactors, which are fitted with solid silver contacts, air-break; the solenoid assembly only is oil-immersed, but **NO MAINTENANCE IS REQUIRED.** This unique design prevents contact bounce by controlling the speed of the contact make and break, thereby increasing the contact life considerably. No other contactor has this feature.



The Illustration shows Automatic Star-Delta Starter with built-on isolator and flush mounting push button station with selector switch.

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GLASGOW: 73 Robertson Street, Glasgow C.2. Tel: CENTral 2479.
NEWCASTLE: Mr. H. Breeze, 4 Beechwood Avenue, Monkseaton, Whitley Bay, Northumberland. Tel: Whitley Bay 24231.
WEST MIDLANDS: 2-3 Graham Street, Birmingham 1. Tel: CENtral 6693.
EAST MIDLANDS: Mr. D. A. Crossley, 38 St. Mawes Avenue, Wilford, Nottingham. Tel: Nottingham 89023.
YORKSHIRE: Mr. H. S. Parry, "Lone Stack", Holly Bush Green, Collingham Bridge, Wetherby. Tel: Collingham Bridge 134.
EIRE: McKenna Distributors Limited, 2 Ashton's Quay, Dublin. Tel: Dublin 78435.
Associated Company: Hindustan Klockner Switchgear Ltd., Bombay.

To **BRITISH KLOCKNER SWITCHGEAR LTD., CHERTSEY, SURREY**

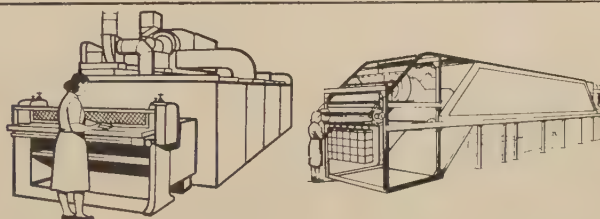
Please send me your latest comprehensive catalogue.

NAME

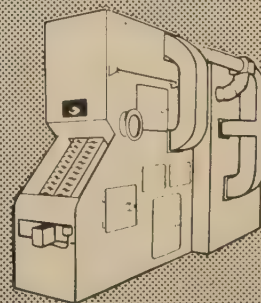
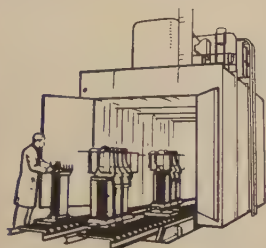
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ADDRESS R 42/47



**CHAL plant for all
electrical equipment
varnish impregnation and baking
transformer spraying and drying
paint drying Bulletin 12**

**CONTROLLED HEAT & AIR LTD.**

Smethwick

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Telephone: Smethwick 1805



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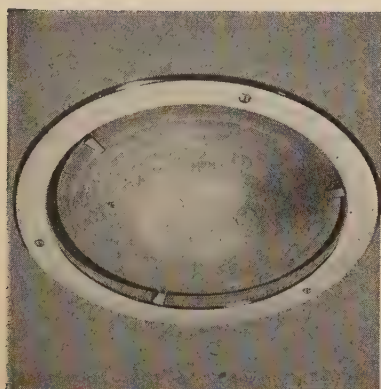
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YOU NEED...**

WELL DESIGNED

LOW COST

SPOT

LIGHT FITTINGS

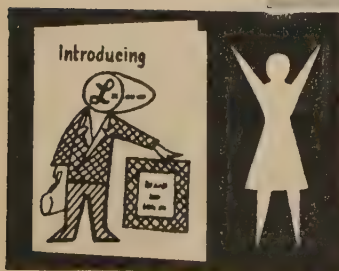


535 BC/100/150W
Recessed ceiling
fitting in aluminium
mirror finish with
lens.

55/-
(Plus 11/- P.T.)

508a SM/BC/100W
Stoved enamel finish
—4 colours—ivory,
black, canary
yellow and signal
red.

32/-



Send for
latest
**SPOT
CATALOGUE**

LUMITRON LTD

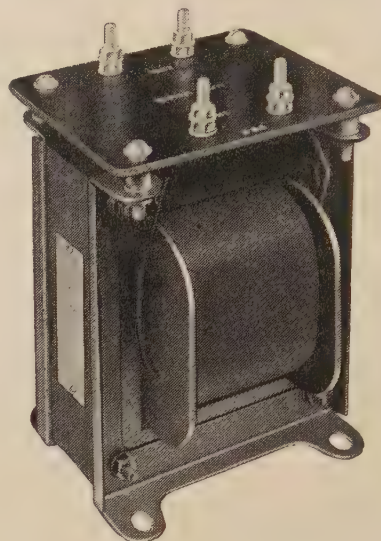
Manufacturers of contemporary lighting fittings

Showrooms and Trade Counter
180 SHAFTESBURY AVENUE, LONDON, W.C.2
OOVent Garden 0126/7

Works and Trade Counter
HYTHE RD., SCRUBBS LANE
N.W. 10. LAD: 2262/3

**Insist on
T.E.C.**

ELECTRONIC CONTROL EQUIPMENT,
POWER AND DISTRIBUTION TRANS-
FORMERS TO 100 kVA, LOW VOLTAGE,
FLASH TEST, RECTIFIER AND DENTAL
PLATING UNITS, METAL WORK,
TRANSFORMER REPAIRS AND CHOKES



Leaflets
on request:—

PRESSED FRAME TYPE
100 V.A. TO 1000 V.A.

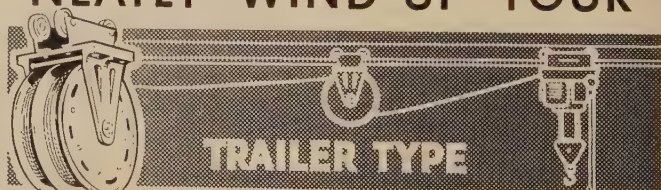
The
TRANSFORMER & ELECTRICAL CO. LTD.
HONYWOOD RD., BASILDON, ESSEX

Telephone: Basildon 20491/3

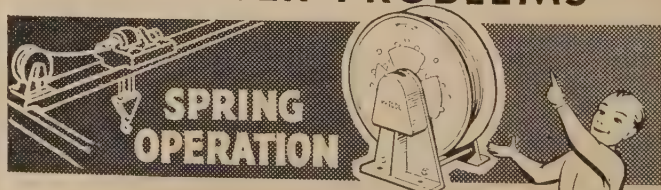
Let **METOO** Cable Collectors



NEATLY 'WIND-UP' YOUR



POWER PROBLEMS



We solve ALL problems relating
to trailing cables and hose.

METROPOLITAN TOOL & PRODUCTS LTD.
21 VICTORIA STREET, NOTTINGHAM.

PHONE: 51651

GRAMS: METOO, NOTTINGHAM



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OFFICIAL NOTICES, TENDERS, ETC.

SYMPOSIUM ON HOSPITAL LIGHTING

A ONE-day Symposium on Hospital Lighting is being held in University College, Gower Street, London, W.C.1, on 5th January, 1962, under the sponsorship of the Ministry of Health and the D.S.I.R. Building Research Station.

The Symposium is designed for architects and engineers, both from Regional Hospital Boards and in private practice, and others particularly concerned with problems of hospital lighting. Papers will be given on the principles of hospital lighting, light sources and engineering, architectural and medical requirements. These will be followed by a discussion.

The Conference will be introduced by Professor Richard Llewelyn Davies and the principal speakers will be Mr. J. Constable, Dr. B. H. Crawford, Mr. J. Green, Dr. S. T. Henderson, Dr. R. G. Hopkinson, Mr. J. Musgrove, Mr. D. J. Petty and Dr. Wellwood Ferguson.

The cost of the Course, including coffee, lunch and tea, will be one guinea. The numbers attending the Course are limited and applications, together with the price of the tickets, should be made as soon as possible to Miss J. M. Beauchamp, Ministry of Health, Savile Row, London, W.1. Cheques and postal orders should be made payable to the Ministry of Health and crossed "Bank of England A/c., H.M. Paymaster General."

2939

INDIA STORE DEPARTMENT

THE Office of the India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington, 8, D.C., United States of America, invites tenders for the following:—

(a) **TENDER ENQUIRY No. S/62/DLF.**

For the supply of 415 volts Motor Central Centres and Motor Lockout Switches for Chandrapura Thermal Power Station, required by Damodar Valley Corporation.

(b) **TENDER ENQUIRY No. S/65/DLF.**

For the supply of an Ash Handling Plant for Chandrapura Thermal Power Station, required by Damodar Valley Corporation.

(c) **TENDER ENQUIRY No. S/66/DLF.**

For the supply of a Coal Transportation and Handling Plant with auxiliaries for Chandrapura Thermal Power Station, required by Damodar Valley Corporation.

Specification, etc., relative to the above enquiries can be obtained from the Coordination Branch, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3, at a cost of (a) 14 shillings and 4 pence per tender, (b) and (c) £1 1s. 5d. per tender. **THE COST OF THE TENDER DOCUMENT IS NOT REFUNDABLE AND THE FORMS ARE NOT TRANSFERABLE.** Tenders are to be returned direct to India Supply Mission, at the above address, and **NOT TO THIS OFFICE**, so as to reach them by (a) 4th January, 1962, (b) 9th January, 1962, (c) 11th January, 1962.

Only the manufacturers (including their constituents or associates authorised to commit

them) or their accredited agents who are in a position to supply the requirements from their own or their principal's manufactures are invited to quote.

Specimen copy of the above enquiries can be seen at India Store Department Engineering Branch, Bromyard Avenue, Acton, London, W.3, under the following references:—

- (a) S.3519/61/NSC/ENG.2
- (b) S.3523/61/NSC/ENG.2
- (c) S.3522/61/NSC/ENG.2

2923

CITY OF LEEDS

Tenders for Street Lighting Equipment

Contract No. 3 (Parts "A" and "B"):
Provision of Lighting at Roundabout (Trunk)
Contract No. 4 (Parts "A" and "B"):
Lighting of Trunk Road

Part of Wetherby Road (Trunk A-58) and its junction with Ring Road Seacroft and Ring Road Shadwell (Trunk A-6120)

TENDERS are invited for the supply and delivery of the undermentioned equipment:

CONTRACT No. 3A. Supply and delivery of 11 reinforced concrete Lighting Columns and Brackets to give mounting height of 35 feet.

CONTRACT No. 3B. Supply and delivery of 11 "Cut-off" Sodium Discharge Lanterns suitable for 200-watt integral sodium lamps, complete with lamps and auxiliary gear within canopy.

CONTRACT No. 4A. Supply and delivery of 26 reinforced concrete Lighting Columns and Brackets to give mounting height of 25 feet.

CONTRACT No. 4B. Supply and delivery of 26 "Non-Cut-off" Sodium Discharge Lanterns suitable for 140-watt sodium lamps, complete with auxiliary gear within canopy.

Specifications, bills of quantities and forms of tender may be obtained from the City Lighting Engineer, City Lighting Department, Springfield Street, Leeds, 12, where the plans and Corporation's general conditions of contract (supply) may be inspected during normal working hours.

The Corporation reserve the right to treat each bill of quantities as a separate tender and do not bind themselves to accept the lowest or any tender.

Tenders in a sealed envelope endorsed "Street Lighting" and bearing no name or mark to indicate the sender must reach the Town Clerk, Room 57, Civic Hall, Leeds, 1, not later than 12 noon on Friday, 15th December, 1961.

L. A. DOXEY,
City Lighting Engineer.

City Lighting Dept.,
Springwell Street,
Leeds, 12.

2958

CLASSIFIED ADVERTISEMENTS ARE PREPAID

Advertisements are accepted up to first post on Monday of the week of issue

If blocks, bold type or ruled borders are required then on Friday prior to week of issue

All communications to be addressed to:
Classified Advertisement Department,
ELECTRICAL REVIEW
Dorset House, Stamford Street
London, S.E.1

Original testimonials should not be sent with applications for employment

BOROUGH OF WREXHAM

Electrical Installation: 108 Dwellings

FIXED PRICE TENDERS are invited for the Electrical Installations to 108 Dwellings on various housing contracts within the Borough.

Applications for tender form and specification should be made to the Borough Engineer and Surveyor, Guildhall, Wrexham.

Completed tenders must be returned to the undersigned in the envelope provided not later than 12 noon, Monday, 4th December, 1961.

The Council does not bind itself to accept the lowest or any tender.

PHILIP J. WALTERS,
Town Clerk.

Guildhall, Wrexham.
November, 1961.

2983

NORTHAMPTON COUNTY BOROUGH EDUCATION COMMITTEE

Barry Schools: Electrical Work

CONTRACTORS wishing to tender for electrical re-wiring and improvements at the above schools should apply to the Borough Architect, Guildhall, Northampton, by the 24th November, 1961, enclosing a crossed cheque for two guineas payable to "Northampton Corporation."

Deposits will be refunded only upon receipt of a bona fide tender, not subsequently withdrawn, by the date and time stated on the tender form. The Education Committee do not bind themselves to accept the lowest or any tender or to pay any costs incurred by persons tendering.

H. A. SKERRETT,
Chief Education Officer.

Springfield,
Cliftonville, Northampton.

2953

INDIA STORE DEPARTMENT

THE INDIA SUPPLY MISSION, 2536, Massachusetts Avenue, N.W., Washington, 8, D.C., invites tenders for the supply of Inter-communication System required for the Chandrapura Thermal Power Station, Damodar Valley Corporation, Calcutta, India.

Tender forms, which are not transferable, may be obtained from the India Store Department (CDN Branch), Government Building, Bromyard Avenue, Acton, London, W.3, on payment of 14s. 4d., which amount is not refundable.

Tender No. S/54/DLF to be quoted in all applications/correspondence.

Closing date for the receipt of tenders in Washington is 28th December, 1961 (11 a.m.).

2966

Official Notices (continued)

ROYAL BURGH OF AYR

Tenders for Underground Cable

THE Town Council invite tenders for the supply of 5,000 yards of Low Tension Twin Core .007 sq. in. (7/.036) Cable with circular conductors, impregnated paper insulated, lead covered, compounded paper double taped, compounded jute served, single-wire armoured, compounded jute served overall. To B.S.S. 480/1954. 1,100 v. class.

Offers marked "Tenders for Underground Cable" are to be lodged with the undersigned within 14 days of the appearance of this advertisement.

ROBERT C. BROWN,
Town Clerk.

Town Buildings, Ayr.

2967

SITUATIONS VACANT

(See "Replies to Box Numbers" on page 105)

Eastern Electricity

Essex Sub-Area
(237/61R)

SENIOR ASSISTANT,
ESTATES & WAYLEAVES SECTION,
SECRETARIAL OFFICER'S DEPT.

The duties will include negotiations for the acquisition of substation sites up to 33 kV, obtaining wayleaves and dealing with agricultural and other damage claims for compensation.

Salary N.J.C. Grade 4 (£934 10s. to £1,060 per annum, inclusive of London allowance).

Apply by letter giving age, education, qualifications, experience and details of present and previous appointments to the Secretarial Officer, Essex Sub-Area, Eastern Electricity Board, Millfield, Bentley, near Brentwood, Essex, by 1st December, 1961.

SOUTH-WEST ESSEX DISTRICT
(236/61R)

FOURTH ASSISTANT ENGINEER.

Applicants should have had a sound technical training and suitable experience in the construction, operation and maintenance of H.V. and L.V. distribution systems, including substations.

Salary N.J.B. Class K, Grade 11 (£1,090-£1,215 inclusive of London allowance).

Apply by letter to W. T. Langfield, Manager, South-West Essex District, Eastern Electricity Board, Ashton Road, Harold Hill, Romford, Essex, by 1st December, 1961.

2956

CHIEF TEST AND INSPECTION
ENGINEER

to be responsible for all testing and inspection of power transformers up to 5 MVA and extensive range of special equipment including transducers, welding transformers, static rectifier sets and voltage regulators. The work includes impulse and noise testing as well as experimental and development testing.

Education level up to H.N.C. is necessary with experience of transformer manufacture and testing, together with the ability to supervise and train personnel and deal with customers.

Apply in writing, giving full details, quoting reference T1, to:—

Chief Engineer
GRESHAM TRANSFORMERS
LIMITED

Twickenham Road, Hanworth, Middx

2932

AUSTRAL STANDARD CABLES

requires a CHIEF ENGINEER

CHIEF
ENGINEER
AUSTRALIA

£A3,500

This Company is Australia's largest telecommunication cable manufacturing company with factories in Victoria, New South Wales and New Zealand.

The Chief Engineer will be based in Melbourne and be directly responsible to the general manager for all technical aspects of the company's business. There are excellent prospects for further promotion.

Candidates aged 35-45 must be graduates in electrical engineering and have at least five years' experience in the communications cable industry.

Salary will be not less than £A3,500 with generous pension arrangements. Passages will be paid and assistance given with housing.

Applications in confidence should be addressed to MPD at the associate company (Standard Telephones and Cables Limited, Connaught House, 63 Aldwych, London, W.C.2.) Quote Ref. ER.25.

2954

CENTRAL ELECTRICITY
GENERATING BOARD

South Eastern Region, North Thames Division

APPLICATIONS are invited for the following appointments at Goldington (Bedford) and Rye House (Essex) Generating Stations:—

GENERAL ASSISTANT ENGINEERS.

Salary N.J.B. within the range of Scales 1/3, £625-£805 per annum plus 10% shift allowance when required to work on shift.

The duties of the successful applicants will include assisting in the control room on shift and other operation and investigation duties.

The commencing salary will depend upon qualifications and the duties and responsibilities.

Preference will be given to applicants who have had previous experience in a generating station and who have reached the standard of the Ordinary National Certificate in Electrical Engineering or its equivalent.

Applications, stating age, qualifications, experience and present position should be sent to the Assistant Regional Personnel Officer, Central Electricity Generating Board, South Eastern Region, North Thames Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts., to arrive not later than 25th November, 1961.

F. W. SKELCHER,
Assistant Regional Director.

2952

EAST MIDLANDS ELECTRICITY BOARD

Sub-Area Secretary:
Leicestershire and Warwickshire Sub-Area
(Vacancy No. 124/61)

Salary £2,170 to £2,380 per annum in accordance with Class C, Grade 5 of the National Joint Managerial and Higher Executive Grades Committee Agreement

APPLICATIONS are invited for the post of SUB-AREA SECRETARY in the Leicestershire and Warwickshire Sub-Area, which will become vacant in February, 1962.

Candidates should have had a wide administrative experience in a senior appointment in the electricity supply industry and should have a professional qualification.

Applications stating age, qualifications, experience, present position and salary should be forwarded to the Secretary, East Midlands Electricity Board, Mapperley Hall, Lucknow Avenue, Nottingham, so as to reach him not later than the 2nd December, 1961. Applications, quoting Staff Vacancy No. 124/61, should be sent in a confidential envelope endorsed "Sub-Area Secretary."

2962

CENTRAL ELECTRICITY
GENERATING BOARD

Midlands Project Group

Second and Third Assistant Engineers
(Mechanical)

APPLICATIONS are invited for the appointments of SECOND and THIRD ASSISTANT ENGINEERS (Mechanical) in the Midlands Project Group at Bournville.

Applicants should preferably be Corporate Members of the Institution of Mechanical Engineers or have qualifications admitting thereto, and should have experience in the design, manufacture and installation of modern power station mechanical plant.

Duties will involve the preparation of specifications, examination of tenders, and general contract development work and correspondence.

The salary will be within Grade 5, Scale 15, £1,460-£1,830 per annum for the Second Assistant Engineer and Grade 7, Scale 13, £1,320-£1,610 per annum for the Third Assistant Engineer.

Applications should be submitted to the Administrative Officer, Midlands Project Group, P.O. Box 314, Birmingham, 30, not later than 1st December, 1961. Envelopes should be marked "Confidential, Staff Vacancy No. MPG.68/61."

2961

ASSISTANT
CHIEF ENGINEER

A LARGE manufacturing company in the Manchester area has a vacancy for an ASSISTANT CHIEF ENGINEER. Essential qualifications are:—

1. A recognised mechanical or electrical engineering qualification.
2. Experience of mechanical and electrical engineering work.
3. Some managerial experience.
4. Initiative and drive.

The starting salary will be in the region of £2,000 per annum and there are good prospects of advancement. Some travelling is involved.

Applications from men in their early 30's should give full details of education, qualifications and career, and should be addressed to—Box 2940.

EAST MIDLANDS ELECTRICITY BOARD

APPPLICATIONS are invited from suitably qualified and experienced persons for the following appointments. Applicants should state age, qualifications, experience, etc., and quote the appropriate vacancy number.

Northamptonshire Sub-Area

THIRD ASSISTANT DISTRICT
COMMERCIAL ENGINEER,
DAVENTRY DISTRICT (Towcester)
(Double-headed) (Vacancy No. 125/61).

Salary N.J.B. Class E, Grades 9 to 10, £765 to £940 per annum, depending on the experience and qualifications of the successful candidate.

The duties will include assisting in the negotiations for the supply of electricity to consumers, advice on tariffs, electrical installations and appliances, sales activities and consumer service, the control of service centres and the preparation of specifications and estimates for electrical installations and the supervision of contracting work.

The person appointed will be required to live in or near Towcester.

Applications should be forwarded to the Manager, Northamptonshire Sub-Area, 25, Bridge Street, Northampton, by the 1st December, 1961.

Mansfield and North Nottinghamshire Sub-Area

SECOND ASSISTANT DISTRICT
COMMERCIAL ENGINEER,
WORKSOP DISTRICT (Double-headed)
(Vacancy No. 126/61).

Salary N.J.B. Class F, Grade 8, £965 to £1,090 per annum. It is anticipated that the Worksop District will be reclassified to Class G from the 1st April, 1962.

The duties will include assisting in the negotiations for the supply of electricity to consumers, advice on tariffs, electrical installations and appliances, sales activities and consumer service, the control of service centres and the preparation of specifications and estimates for electrical installations and the supervision of contracting work.

Ability to drive a motor vehicle is essential, and the person appointed will be required to live in or near Worksop.

Applications should be forwarded to the Manager, Mansfield and North Nottinghamshire Sub-Area, Line Tree Place, Mansfield, Notts., by the 1st December, 1961.

2963

ELECTRICAL ENGINEERS,
MINISTRY OF WORKS, KENYA

QUALIFICATIONS: Candidates, aged 26-45 years, must be A.M.I.E.E. or Grad. I.E.E. with administrative ability, and should have knowledge of thermal and hydraulic prime movers, instruments and testing and workshop practice, including factory regulations. Experience is required in either (a) the design of the electrical content of schools, hospitals, airfields, etc., or (b) in the work and legislation controlling distribution and supply of electricity in a public electricity supply undertaking.

DUTIES: Officer will be employed initially in the sphere of his principal experience, but will be expected to work in other spheres mentioned after appropriate guidance.

TERMS: On contract for two tours of 24 months in the first instance.

TOTAL EMOLUMENTS (salary plus gratuity) in scale £1,582 - £3,060 p.a. Free passages. Generous leave. Free medical attention. Education allowances up to £200 per child.

Apply Director of Recruitment, Department of Technical Co-operation, Carlton House Terrace, London, S.W.1, quoting BCD.112/7/027/D11, giving full name, age and brief details of qualifications and experience.

2927

RTB

RICHARD THOMAS & BALDWIN LIMITED
SPENCER WORKS

Applications are invited for the following vacancies in the

ELECTRICAL ENGINEERING DEPARTMENT

of the integrated iron and steel plant now under construction at Llanwern, near Newport, Mon.

SHIFT CONTROL ENGINEERS

The successful candidates will be required to man a distribution control centre handling voltages up to 275 kV and the Works' own generating plant. This is highly responsible work; previous experience is essential, and applicants must have a knowledge of modern switchgear and protective systems. They should also have served a recognised apprenticeship.

Age range: 22-50.

Please quote Ref. No. 202/5A in your original letter of application.

SENIOR TECHNICIANS, OPERATION

Applicants should have operating experience with high-voltage switchgear, transformers, and rectifiers on a large distribution system, and should be familiar with 'permit to work' procedure.

Successful candidates will be required to work shifts, and will assist the Shift Control Engineer in maintaining supplies throughout the plant. This will include carrying out switching operations and assisting with fault-finding on equipment at voltages up to 33 kV.

Age range: 25-45.

SENIOR TECHNICIAN, PROTECTION

Applicants should have experience in commissioning, testing, and maintaining protective gear for alternators, transformers, rectifiers, and other high-voltage equipment.

Age range: 25-45.

All the above are staff positions, and candidates should possess a Higher National Certificate in Electrical Engineering. The work offers exceptional opportunities for those who are interested in the latest techniques of control engineering as applied to heavy industry.

Please quote Ref. No. 202/7A in your original letter of application for Senior Technicians, Operation, and Senior Technicians, Protection.

Application forms, which should be returned by 24th November, may be obtained from

The Manager, Staff and Labour Relations Department

RICHARD THOMAS & BALDWIN LIMITED

Spencer Works, Llanwern, Nr. Newport, Mon.

2926

BOROUGH OF WILLESDEN

APPPLICATIONS are invited for suitably qualified and experienced persons for the following appointment:—

SENIOR ELECTRICAL ENGINEER,
Scale B (£1,505-£1,670 p.a.).

Candidates should have experience in the design of electrical installation in multi-storey blocks of flats and public buildings.

The Council are prepared to make a mortgage advance for house purchase and a contribution up to £25 towards the cost of removal expenses.

Full details and form of application may be obtained from Borough Engineer, Town Hall, Dyne Road, Kilburn, London, N.W.6, and should be returned by not later than 10 a.m. on Monday, 4th December, 1961.

R. S. FORSTER,
Town Clerk.

2933

MIDDLESEX COUNTY COUNCIL
EDUCATION COMMITTEE

Southall Technical College,
Beaconsfield Road, Southall, Middlesex

Principal: J. V. Tee, Wh.Sch., B.Sc.(Eng.),
A.C.G.I., D.I.C., M.I.E.E., A.M.I.Mech.E.

APPPLICATIONS are invited for appointment as SENIOR LECTURER to teach Electrical Engineering to Higher National Certificate and Diploma standard, duties to commence on 1st January, 1962, or as soon as possible afterwards. Candidates should be university graduates with good teaching experience and appropriate industrial experience. Special interest in automatic control, electricity supply or utilisation would be an additional recommendation.

Salary £1,845-£2,060 per annum.

Further particulars and a form of application may be obtained from the Principal. Closing date for receipt of completed forms, two weeks from the date of this advertisement.

C. E. GURR, M.Sc., Ph.D.,
Chief Education Officer.

2965

SALES ENGINEER

required for inside position by manufacturers of rotary electrical equipment in London area. Applicants should be aged 24-30, have some commercial experience and hold a technical qualification.

Present employees have been notified of vacancy.

Write giving full particulars to—Box 2957.

ESTABLISHED ELECTRICAL DISTRIBUTORS AND WHOLESALE MANUFACTURING AND IMPORTING DIRECT ARE PREPARED TO INTERVIEW AS REPRESENTATIVES MEN WITH ESTABLISHED CONNECTIONS IN THE ELECTRICAL TRADE FOR POSTS IN A COMPANY WITH RAPIDLY EXPANDING SALES.

ALL ENQUIRIES TREATED IN CONFIDENCE.

WRITE GIVING FULL DETAILS—BOX 2913.

Situations Vacant (continued)**YORKSHIRE ELECTRICITY BOARD****Head Office****DEPUTY CHIEF ENGINEER.**

Applications for the position of Deputy Chief Engineer are invited from suitably qualified and experienced engineers. Corporate Membership of the Institution of Electrical Engineers is an essential qualification.

Salary N.J.M. & H.E. Class D, Grade 9, £3,270/£3,515 per annum.

Applications, together with the names of two referees, should be sent to the Secretary, Yorkshire Electricity Board, Wetherby Road, Scarcroft, Leeds, not later than 27th November, 1961.

No. 3 (Sheffield) Sub-Area**SUB-AREA COMMERCIAL OFFICER**

Applications are invited for the appointment of Sub-Area Commercial Officer in the No. 3 (Sheffield) Sub-Area. Applicants should have a sound knowledge of tariffs, experience of negotiations with consumers, management of service centres and supervision of contracting work. Possession of an appropriate professional qualification is desirable.

Salary N.J.M. & H.E. Class E, Grade 5, £2,595/£2,815 per annum.

Applications, together with the names of two referees, should be sent to the Manager, No. 3 (Sheffield) Sub-Area, Yorkshire Electricity Board, Change Alley, Sheffield, not later than 27th November, 1961.

No. 7 (Grimsby) Sub-Area**SUB-AREA ENGINEER**

Applications are invited from professionally qualified electrical engineers for the appointment of Sub-Area Engineer in the No. 7 (Grimsby) Sub-Area.

Salary N.J.M. & H.E. Class B, Grade 6, £2,170/£2,380 per annum.

Applications, together with the names of two referees, should be sent to the Manager, No. 7 (Grimsby) Sub-Area, Yorkshire Electricity Board, Moss Road, Grimsby, not later than 27th November, 1961.

No. 4 (Leeds) Sub-Area**SECOND ASSISTANT ENGINEER**

(Operation and Maintenance).

Applicants should have had considerable experience in the operation and maintenance of substation equipment, overhead and underground distribution systems operating up to 66 kV. A sound knowledge of all relevant safety requirements and regulations is essential.

Salary N.J.B. Class L, Grade 7 (Scale 13), £1,440/£1,610 per annum.

Applications, together with the names of two referees, should be sent to the Manager, No. 4 (Leeds) Sub-Area, Yorkshire Electricity Board, Bramhope, Leeds, not later than 1st December, 1961.

No. 1 (Bradford) Sub-Area**THIRD ASSISTANT ENGINEER**

(Draughtsman).

This vacancy is in the Construction Engineer's Section of the Sub-Area Engineer's Department, at present located at Dockfield, Shipley. The successful candidate will be required to lead the Building and Civil Section, the principal duties of which are the preparation of drawings and estimates for new building works and for alterations to existing buildings. A knowledge of tender procedure and contract supervision would be an advantage.

Salary N.J.B. Class L, Grade 10 (Scale 10), £1,190/£1,325 per annum.

Applications, together with the names of two referees, should be sent to the Manager, No. 1 (Bradford) Sub-Area, Yorkshire Elec-

tricity Board, 45/53, Sunbridge Road, Bradford, 1, not later than 1st December, 1961.

**No. 5 (Wakefield) Sub-Area
BARNSELY DISTRICT****ASSISTANT INSTALLATION ENGINEER.**

Applicants must have had a sound technical education and practical experience in electrical contracting work of all types. They must be capable of preparing supervising schemes for all classes of domestic, commercial and industrial installations, including specifications, estimates and tenders. Experience in electrical appliance repairs would be considered an advantage. Applicants must have had considerable experience in the control of workmen.

Salary N.J.B. Class J, Grade 10 (Scale 8), £1,040/£1,165 per annum.

Applications, together with the names of two referees, should be sent to the Manager, No. 5 (Wakefield) Sub-Area, Yorkshire Electricity Board, 1a, Denby Dale Road, Wakefield, not later than 1st December, 1961.

2960

NORTH WESTERN ELECTRICITY BOARD**Second Assistant District Engineer,
North-West District, Eccles**

The duties will include the supervision of the erection and maintenance of substation switchgear, laying and jointing of cables, and switching operations on the H.V. and L.V. systems within the District as required. Applicants should have had a wide general experience on the distribution side of electricity supply and be prepared to undertake standby duties. Corporate Membership of the Institution of Electrical Engineers will be an advantage.

Salary scale £1,190/£1,325 p.a., Grade H.7. N.J.B. conditions.

Applications on forms to be obtained from the Manager (Staff Vacancy), No. 1 Sub-Area, North Western Electricity Board, Town Hall, Manchester, 2, P.O. Box 493, and returned to him by 27th November, 1961.

**Second Assistant Engineer (Construction),
Sub-Area Engineering Dept., Kendal**

Applicants should be experienced in the construction of H.V. and E.H.V. overhead lines on wood poles and steel towers and in the laying of 11-kV and 33-kV underground cables. Experience in the preparation of specifications covering the installation of overhead lines and underground cables will be an advantage. Experience also in the design and construction of 33-kV substations will be necessary.

The minimum technical qualification will be the H.N.C. in Electrical Engineering or equivalent.

Salary scale £1,350/£1,500 p.a., Grade K.7. N.J.B. conditions.

Applications on forms to be obtained from the Manager, No. 6 Sub-Area, North Western Electricity Board, Castle Green, Kendal, and returned to him by 27th November, 1961.

2946

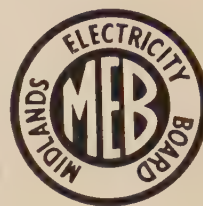
ABERDARE CABLES LTD.**Manufacturers of
Paper and Plastic Insulated Cables**

require an ELECTRICAL ENGINEER to take control of their development department. This will be a senior position responsible directly to the Chief Engineer.

Applicants must possess an engineering degree, have had some cable experience, and preferably some knowledge of experimental techniques. Age 28-32.

Apply by letter, in strict confidence, giving complete details of technical qualifications, experience and salary to the Secretary, Aberdare Cables Limited, Aberdare, Glamorgan.

2971

**MIDLANDS
ELECTRICITY
BOARD**

APPLICATIONS are invited for the following superannuable posts:—

Birmingham Area**THIRD ASSISTANT ENGINEER**
(Technical and Planning Section,
Area Engineer's Dept., Headquarters).

The successful applicant will be required to assist in the design of the H.V. and M.V. networks, analysis of loading conditions, preparation of specifications and layout of plant and equipment.

Salary £1,275/£1,410 per annum or £1,350/£1,500 per annum (N.J.B. Grade N.11 or N.10) according to qualifications and experience.

Apply by letter within 14 days, stating age, experience, present position and salary to Emil Braathen, Manager, Midlands Electricity Board, 14, Dale End, Birmingham, 4.

Central Gloucestershire Area**DEMONSTRATOR (Female)**
(Stroud).

Applicants must have had a good education and should have a certificate of a recognised domestic training college and/or the E.A.W. Certificate, and have had at least two years' training and experience. Applicants must be prepared to take an active part in the sales organisation and selling experience would be an advantage. Duties include lecture demonstrations in service centres and on consumers' premises, and advice to consumers on the selection and use of electrical apparatus.

Salary £600/£700 per annum (N.J.C. Grade 1).

Apply by letter within 14 days, stating age, education, qualifications, training and experience, to Mr. S. Raybould, Area Manager, Midlands Electricity Board, Eastern Avenue, Gloucester.

Shropshire and Herefordshire Area**ASSISTANT (Purchasing Department,
Area Headquarters).**

Duties include the maintenance of stores reference lists and continuous review of stores holdings.

Salary £700/£775 per annum (N.J.C. Grade 2).

Apply by letter, stating age, qualifications, experience, present position and salary, to Mr. W. Winwood, Area Manager, Midlands Electricity Board, Spring Gardens, Ditherington, Shrewsbury.

F. W. CATER,
Secretary.

2944

**NORTHAMPTON COLLEGE OF
ADVANCED TECHNOLOGY****Electrical Engineering Department**

APPLICATIONS invited for new post of CHIEF SENIOR LABORATORY TECHNICIAN in the above Department. Duties involve supervision of laboratory staff, responsibility for the planned maintenance of equipment, and construction of new apparatus.

Candidates should possess a Higher National Certificate in Electrical Engineering, or equivalent, and have had appropriate industrial experience. The post is permanent and pensionable, with five weeks' annual leave.

Salary £940 × £30 to £1,060 p.a.

Applications to Head of Department, St. John Street, London, E.C.1.

2973

SOUTHERN ELECTRICITY BOARD

Third Assistant Engineer
(Maintenance and Operation)

Sub-Area Engineer's Department of No. 4 (Bournemouth) Sub-Area. Salary N.J.B. Class M, Grade 11 (£1,190-£1,325 per annum). N.J.B. conditions of service.

The successful applicant will be required to assist the Senior Assistant Engineer (Technical) in his duties, including the maintenance of fault and other statistics and records; network protective gear and switchgear problems, and a variety of technical work relating to commissioning, operation and maintenance of the Board's distribution systems. Applicants should have had experience in the design, construction, operation and maintenance of H.V. and L.V. overhead and underground distribution systems. The possession of suitable technical qualifications would be an advantage.

Applications on forms obtainable from the Sub-Area Secretary, 1, Priory Road, Bournemouth, Hants, and returned to him, quoting Z.1344, not later than 27th November, 1961.

Demonstrator

Basingstoke District of No. 3 (Portsmouth) Sub-Area. Salary N.J.C. Grade 1 (£600 × £25 to £700 per annum). N.J.C. conditions of service.

Applicants should be qualified to advise generally on the utilisation of electric domestic appliances, to give public demonstrations of apparatus and to assist in showroom duties. The possession of an E.A.W. Certificate or equivalent domestic science qualification would be an advantage.

Applications on forms obtainable from the Sub-Area Secretary, Lower Drayton Lane, Cosham, Portsmouth, and returned to him, quoting Z.1433, not later than 27th November, 1961.

The successful candidates for the above appointments will be required to contribute to the Electricity Supply (Staff) Superannuation Scheme, if eligible.

2969

TECHNICAL
OFFICER

The British Electrical Development Association requires a technical officer specially expert in promoting the use of electricity for domestic purposes. Ability to write fluently and clearly is essential. Knowledge of publicity and film making very advantageous. Corporate membership of I.E.E. desirable. Salary in the region of £2,000 depending on age and qualifications.

Applications, giving full particulars of education, training, qualifications, age and experience to be sent before 1st December to:—

Director & Secretary
The British Electrical Development Association
2 Savoy Hill, London, W.C.2

2887

CROMPTON PARKINSON
(CHELMSFORD) LTD.

require a

SENIOR TEST ENGINEER

AN experienced man, conversant with the testing of medium sizes A.C. and D.C. machines, is required in our rotating machine test section.

Applications should be sent in confidence to Personnel Officer, Crompton Parkinson (Chelmsford) Ltd., Writtle Road, Chelmsford. Essex.

2972

J. & P.

MANAGER OF
SWITCHGEAR
DEPARTMENT

Johnson & Phillips Ltd. invite applications for the position of Manager of their Switchgear Department. The man appointed will be responsible to the Board for the whole of the Company's switchgear activities including the development, production, commercial and administrative aspects. These activities include the control of the technical policy of the Company's overseas factories in South Africa, Australia, India and Pakistan. The Company's main switchgear factory is situated at New Cross, London. The vacancy arises from the sudden decease of Mr. P. T. Davies, B.Sc., A.M.I.E.E.

Applications giving full details of qualifications, age and experience should be addressed to the

Director and General Manager

Johnson & Phillips Ltd., Charlton, London, S.E.7

2950

CENTRAL ELECTRICITY
GENERATING BOARD

Operational Services Engineer

APPLICATIONS are invited for the appointment of OPERATIONAL SERVICES ENGINEER in the Nuclear Operations Branch of the Operations Department at Headquarters, Friars House, London, S.E.1.

This is a senior post and the successful candidate will be responsible for co-ordinating the operation, maintenance and staffing of the Board's nuclear power stations.

Candidates should preferably possess a university degree in engineering and be corporate members of a senior engineering institution. Experience in the nuclear field is desirable though not essential, but candidates must possess sound practical experience of the operation and management of power or heavy engineering plant.

Salary within the scale £2,440-£2,655 per annum.

Applications stating age, qualifications, experience, present position and salary to Mr. H. C. Spear, Chief Personnel Officer, 24/30, Holborn, London, E.C.1, by 4th December.

Quote Ref. ER/509.

2959

CENTRAL ELECTRICITY
GENERATING BOARD

South Thames Division

Littlebrook Power Station

ASSISTANT ENGINEER (Efficiency)
(Vacancy No. 176A/61).

The successful applicant will assist in the Station Efficiency Section in investigations into the thermal performance of plant. Technical qualifications to O.N.C. standard are desirable and practical experience in generating station work would be an advantage.

Salary N.J.B. Class L, Grade 16, £815-£920 per annum, including London allowance.

Applications giving age, details of experience, qualifications, etc., should be sent to the Station Superintendent, Littlebrook Power Station, near Dartford, Kent, to arrive by 24th November.

2955

SOUTH EASTERN ELECTRICITY BOARD

SENIOR SHOWROOM ASSISTANT,
Kingston District.

Salary £780 × £25 to £880 in accordance with N.J.C. Grade 3 plus London weighting. Superannuable. The position calls for an enthusiastic salesman with drive and initiative for the Kingston showroom. The successful applicant may be required to work at any of the District showrooms. Applicants should have had experience in electricity showrooms and be capable of controlling staff, advising consumers on appliances and tariffs and dealing with general enquiries. Possession of E.D.A. Salesmanship Certificate an advantage.

Applications, quoting ER, on forms from District Manager, SEEBOARD, 22, Claremont Road, Surbiton, Surrey, by 29th November, 1961.

FITTER (Electrical),
Brighton and Hove District.

Wages 5s. 6½d. per hour for a 42-hour, 5-day week under N.J.I.C. Agreement. Candidates should have served a recognised craft apprenticeship and have had experience in the erection and maintenance of high-voltage and medium-voltage switchgear, transformers and associated control equipment. Contributory pension scheme optional.

Applications, quoting ER and naming 2 referees, to District Manager, SEEBOARD, Electric House, Castle Square, Brighton, by 27th November, 1961.

GEORGE WRAY,
Secretary.

2968

OVERSEAS
ELECTRICAL CONTRACTOR

requires competent BRANCH MANAGER for West Africa with contracting experience from enquiry to final account and experience of controlling branch with turnover of £1M.

Excellent conditions and prospects. Full details given at interview.

Applications in writing giving details of past experience to—Box 2860.

Situations Vacant (continued)**KENT EDUCATION COMMITTEE**

North-West Kent College of Technology

Electrical Engineering Department

LECTURER IN ELECTRICAL ENGINEERING required to teach up to Higher National Certificate standard in Electrical Machines and/or Power Supply. The lecturer will be responsible for a well-equipped machines laboratory which will shortly be transferred to new premises.

GRADE B ASSISTANT required to teach **ELECTRICAL SUBJECTS** to National Certificate and Technician classes. Specialised experience in a Power Engineering subject would be an advantage. Industrial and/or teaching experience essential.

Salary for both the above appointments in accordance with the new Burnham Technical award :-

Lecturer: Proposed scale £1,600 - £1,800. Subject to ratification.

Grade B Assistant: Proposed scales within the range £770 - £1,440, with improved scales for graduates. Subject to ratification.

Further particulars and forms of application for both the above appointments may be obtained from the Principal at the College, Miskin Road, Dartford.

2941

**BRITISH RAILWAYS
(WESTERN REGION)****TECHNICAL ASSISTANT
GENERAL DRAWING OFFICE,
SWINDON**

to take charge of section dealing with the design of industrial electrical installations, including high and medium-voltage supplies, substations, electric lifts, capstans, etc. Sound technical training in both mechanical and electrical engineering essential.

Commencing salary £1,050 p.a. rising to £1,125 after two years.

Superannuation scheme. Sick pay. Travelling facilities.

Applications to :-

**Chief Mechanical & Electrical Engineer
BRITISH RAILWAYS
Western Region, Swindon, Wilts**

2924

**CENTRAL ELECTRICITY
GENERATING BOARD**

North Eastern Region

Regional Electrical Department

Fourth Assistant Engineers (Planning)

APPLICATIONS are invited from suitably qualified engineers for a position as a **FOURTH ASSISTANT ENGINEER** in the System Planning and Development Section of the Regional Technical Branch at Leeds. The successful candidate will be required to assist with system studies employing A.C. and D.C. calculators, and with planning extensions to the transmission system.

The salary for these appointments will be in accordance with the National Joint Board Agreement, Class K, Grade 9, 10 or 11 (£900-£1,325 per annum) according to qualifications and experience.

Forms of application may be obtained from the Regional Personnel Officer, Central Electricity Generating Board, North Eastern Region, 1, Whitehall Road, Leeds, 1, to whom they should be returned to arrive not later than 4th December, 1961.

2982

SOUTH WESTERN ELECTRICITY BOARD

APPLICATIONS are invited for the following position :-

**THIRD ASSISTANT DISTRICT
ENGINEER (Protection) Torbay.**

Salary within Class G, Grade 9, Salary Scale 7 (£965 to £1,090 per annum) of the N.J.B. Agreement.

Duties will include the maintenance of all protective gear in the District; the carrying out of pressure tests and fault location tests, and assistance to the Construction Engineer, when necessary, on the installation of switchgear and protective gear. The person appointed may be required to undertake standby duty.

Corporate Membership of the Institution of Electrical Engineers or technical qualifications leading thereto are desirable, together with the possession of a current driving licence.

Applications to be made on standard form AE6/ACT, OBTAINABLE BY POSTCARD ONLY from the District Manager, South Western Electricity Board, Electric House, Union Street, Torquay. Closing date for receipt of completed applications is 2nd December, 1961.

2970

**MERSEYSIDE AND NORTH WALES
ELECTRICITY BOARD**

Appointment of Secretary, No. 4 Sub-Area

APPLICATIONS are invited for the above appointment at the Headquarters of the Board's No. 4 Sub-Area at Rhostyllen, near Wrexham. The Sub-Area covers North Wales and parts of Cheshire and Shropshire.

Duties will include establishments and personnel matters, the acquisition of property and wayleaves and general administration. Experience in common law claims and insurance, and a knowledge of superannuation schemes will be an advantage.

Candidates should preferably possess a recognised secretarial or other suitable qualification.

The salary will be in the range £2,380 to £2,595 per annum.

Applications should be submitted to the Secretary at Board Headquarters, Love Lane, Liverpool, 3, so as to be received not later than 8th December, 1961.

2984

MIDDLESEX COUNTY COUNCIL

County Architect's Department

ELECTRICAL ENGINEERING ASSISTANT required. A.P.T. II (£815 to £960 plus London weighting up to £40). Established. Prescribed conditions.

Should have practical experience of installation work in buildings or knowledge of electrical contractor's office procedure to assist in preparation of drawings and specifications covering wiring of buildings.

Application forms (s.a.e.) from County Architect, 1, Queen Anne's Gate Buildings, Dartmouth St., London, S.W.1, returnable by 27th November (quote H.829 ER).

2964

**BRITISH ENGINE BOILER &
ELECTRICAL INSURANCE CO. LTD.
Longridge House, Manchester, 4**

ELECTRICAL SURVEYORS required in England and Scotland. Permanent positions carrying progressive salary scale £825 to £1,225 with non-contributory pension. Candidates, aged 26 to 32, with H.N.C. in Electrical Engineering or Grad. I.E.E., and with apprenticeship in manufacture or repair of electrical machinery, are invited to apply stating age, qualifications and experience.

2938

ASSISTANT ELECTRICAL ENGINEER

required by Trinity House, London, the General Lighthouse Authority for England and Wales.

Applicants should have a sound fundamental training in electrical engineering and design, with installation experience of a wide variety of electrical equipment, including small-scale distribution, generators and motors up to 50 kW/h.p. and electro-mechanical devices. In particular experience in light current relay circuitry and techniques associated with automatic control and instrumentation of industrial plant is desirable with some knowledge of the application of electronics including semi-conductor devices to industrial control systems or telecommunications would be an advantage.

Candidates, who should be of British nationality, should be Corporate Members of the Institution of Electrical Engineers, or have passed the necessary qualifying or exempting examinations.

Commencing salary will depend on age (maximum £1,318 per annum at age 34 or over) within the scale £991 (age 25) to £1,490 per annum.

Applications should be made in writing to the Secretary, Trinity House, Tower Hill, London, E.C.3, not later than 27th November, 1961, stating age, present occupation, qualifications and experience, and enclosing copies of recent testimonials.

2934

CORPORATION OF LONDON

City Surveyor's Department

APPLICATIONS are invited for appointment as **ELECTRICAL ENGINEERING ASSISTANT**; salary up to £1,310. The post is permanent and superannuable and subject to medical examination.

Candidates should be Graduate Members of the Institution of Electrical Engineers and have had experience in preparation of schemes for electrical lighting, heating and power installations in public buildings, electric lifts and small ventilating schemes and the maintenance of existing services.

Applications, stating age, previous appointments and experience, with names and addresses of two referees, to the City Surveyor, Guildhall, London, E.C.2, within 14 days.

2974

**COUNTY BOROUGH OF BURNLEY
EDUCATION COMMITTEE**

Burnley Municipal College

Department of Electrical Engineering

APPLICATIONS are invited for the post of **LECTURER** in Electrical Engineering, to commence duties as early as possible.

Candidates should possess a good degree in electrical engineering and/or be a Corporate Member of the Institution of Electrical Engineers and should be prepared to teach electrical engineering subjects up to and including Higher National Certificate, together with A.2 Electronics.

An interest in electronics coupled with teaching and industrial experience would be additional recommendations.

Salary in accordance with the Burnham Technical Scale, at present £1,370-£1,550 per annum.

Forms of application obtainable from the Director of Education, Education Office, Manchester Road, Burnley, to whom they must be returned within 14 days of the appearance of this advertisement.

**C. V. THORNLEY,
Town Clerk.**

2975

TECHNICAL SALES REPRESENTATIVE

REPRESENTATIVE required to be based on our Bristol office and to cover the South-West of England for the sale and application of transformers and of power capacitors. A knowledge of the area and some experience of technical sales are desirable but not essential.

Applications in confidence to:—

Sales Director
BRUCE ELECTRIC
CONSTRUCTION CO. LTD.
Kelvin Works, Hackbridge, Surrey

2888

SOUTH WALES ELECTRICITY BOARD

General Assistant Engineer (Draughtsman)

APPPLICATIONS are invited for the position of GENERAL ASSISTANT ENGINEER (Draughtsman) in the Mid-Wales and North Mon. (Brecon) District of the Monmouthshire and Mid-Wales Area.

Salary N.J.B. Class E. Grade 10, Scale 4 £765/£870 per annum).

Applications stating age, present position, present salary, qualifications and experience should be addressed to W. E. Richardson, M.I.E.E., Manager, Monmouthshire and Mid-Wales Area, Llywelwyn Road, Cwmbran, Mon., to arrive not later than 2nd December, 1961.

Please quote reference 102/61/ER, endorsing envelope "General Assistant Engineer (Draughtsman)".

Previous applicants need not re-apply as their applications will be reconsidered.

R. G. WILLIAMS,
Secretary.

2951

NORRIS CONSULTANTS LIMITED

require in the Bristol and Reading offices

ELECTRICAL ENGINEERS.

ELECTRICAL
DESIGNER/DRAUGHTSMEN.

Applications are invited from engineers and draughtsmen with experience in building installations, distribution and control equipment.

Send full details, quoting reference M.R.N., to Beacon House, Queen's Road, Clifton, Bristol, 8.

2914

CONSULTING ENGINEERS

require the services of

ELECTRICAL CONTRACT ENGINEERS

with experience of overhead line distribution and substation work up to 132 kV. Corporate membership of one of the senior institutions. Salary in accordance with qualifications and experience. Bonus and pension schemes.

Applications giving full details of age, qualifications and experience to be made in writing within fourteen days to Preece, Cardew & Rider, 8-12, Queen Anne's Gate, Westminster, London, S.W.1.

2931

CENTRAL ELECTRICITY GENERATING BOARD

West Midlands Division

STATION SHIFT CONTROL ENGINEER

is required at Ocker Hill Power Station, Tipton, Staffs. N.J.B. service conditions, superannuable appointment, salary within Schedule A of the Agreement, Grade G.10, £890 to £1,015 per annum, plus 10% shift allowance (minimum £90).

A sound technical training and practical experience in the control of steam generating plant and main switchgear are required. Appropriate technical qualifications an advantage.

Apply, quoting Vacancy No. 257/61MR, on form AE6, available from the Station Superintendent, Ocker Hill Power Station, Bayley's Lane, Ocker Hill, Tipton, Staffs., by 27th November, 1961.

2945

GESTETNER LIMITED

Tottenham, London, N.17

require an

ASSISTANT ELECTRICAL ENGINEER

to take charge of Electrical Maintenance Department in their North London factory. Electrical consumption 2,500 kVA.

Applicants should be about 35 years of age and hold the H.N.C. in Electrical Engineering.

Applications to the Personnel Officer, Gestetner Limited, Fawley Road, Tottenham, London, N.17, or telephone TOTtenham 1050.

2925

MOTOR CONTROL GEAR SALES ENGINEERS

OWING to expansion of the company's activities we have a number of vacancies for TECHNICAL SALES REPRESENTATIVES in the London, Midlands and Northern areas. Applicants should either possess H.N.C. in Electrical Engineering, or equivalent, or have had experience in the field of motor control gear.

* Applications giving full details of qualifications and experience should be sent to

The Secretary
MORECAMBE ELECTRICAL
EQUIPMENT COMPANY LIMITED
Westgate Works, Morecambe

2949

OVERHEAD TRANSMISSION LINE ENGINEERS

LARGE contracting organisation has vacancies for AGENTS, SUB-AGENTS and ENGINEERS on 275-kV and 132-kV steel tower and wood pole line contracts in Scotland.

State age and give full particulars of experience to Box 577, Keith & Co., 11, Castle Street, Edinburgh.

2935

ADDITIONAL supervising engineer for London contractor. One able to run contracts from inception to final accounts and be responsible to manager for same. Only person who has had several years' experience in similar capacity would suit. Good salary and prospects. —Box 106.

AN experienced armature winder, also an electrical tester, is required by Max Arc Ltd., of Walton-on-Thames, Surrey. Congenial atmosphere. Good prospects for the right person.

176

A SENIOR and a junior electrical engineer required in Glasgow by a large organisation for the preparation of drawings, specifications and installation of a wide variety of equipment. Write Chief Engineer, The Distillers Co. Ltd., Engineering Division (North), 64, Waterloo Street, Glasgow, C.2, stating age, experience, qualifications and salary expected. 2878

A SST. branch manager reqrd. by elec. wholesaler, Luton district. Must have good knowledge of the trade and administrative ability. Apply in writing to—Secy., L.E.C., 92, Blackfriars Rd., London, S.E.1. 2976

BOOK-keeper, male or female. This is a responsible position and a good salary will be paid. Please state present earnings and when available. References would be required. —Box 107.

CHIEF inspector, fully experienced, required by relay and electrical control gear manufacturers to take charge of test department. Boreham Wood, Herts. district. Telephone Elstree 2291 or write to—Box 2832.

CONSULTING engineers require senior electrical designer (building services) capable of planning and designing services all types buildings, including boiler houses, etc., with minimum supervision. Junior also required. Send details—Hoare, Lea & Partners, Building 332 (South Side), R.A.F., Northolt, Ruislip, Middlesex. 8375

CONTRACTORS who specialise in overhead line and cable laying contracts require young engineers and young foremen with experience and initiative.—Box 2789.

ELECTRICAL cable makers require experienced representative for Scotland. Remuneration above average with ample scope for improvement. Successful applicant would be required to take control of branch premises in Glasgow. Some experience of the radio and television industry would be an added advantage. Car provided. Pension scheme. Apply in strict confidence to Sales Director, Permanoid Limited, Manchester, 4. 2863

ELECTRICAL draughtsman, age 25-45, wanted for development work associated with electrical power cables and accessories. H.N.C. (Elect.) preferred, but not essential if applicant has some electrical drawing office experience. Write stating full particulars, salary required, etc., to—Engineering Manager, Power Cables Dept., Associated Electrical Industries Ltd., Cable Division, Gravesend, Kent. 2978

ELECTRICAL draughtsman/engineer required by electrical consultants.—Brown & Hooker, 123 Warwick Rd., London, S.W.5. 2790

ELECTRICAL installations draughtsman required by leading company of London engineers. Preference given to applicants with experience on power and lighting distribution. Progressive appointment in congenial surroundings for man with initiative and drive. Salary subject to negotiation but probably between £105-£125 per month. Applications to Box 2936, please, giving details of appointments held, etc.

ELECTRICIAN required for plant maintenance. Ability to drive and willingness to travel an advantage. Based at Isleworth. Apply—Trollope & Colls Ltd., Plant Yard, Worton Road, Isleworth, Middx. (Telephone ISLeworth 8314, Mr. France). 2918

ESTIMATING/supervising and/or design and also junior engineer required for progressive positions for high-class installation work in an expanding company. Write in confidence stating age, experience in detail and salary required to—Managing Director, Alliance Electrical, 2, Henrietta St., London, W.C.2. Progressive salary and scope for advancement for able and enthusiastic engineers. 137

MAJOR petroleum distribution company require for their London office a fully experienced electrical engineer for development of new projects and the maintenance of existing electrical installations. Applicants preferably should have experience in flameproof construction, be familiar with codes of practice relative thereto, and be well versed in the technical supervision of contracted work. Progressive salary, permanent career, first-class pension scheme covering widows and dependent children. Legal fees and removal expenses involved in house transfer paid for married men. Please reply by brief letter giving details of age, education, qualifications and previous experience to Box XA.122, c/o Mathers & Streets, 110, Old Broad Street, London, E.C.2, quoting reference No. D/293. Replies can only be sent to those selected for interview. 2928

Situations Vacant (continued)

MEDWAY WATER BOARD require electrical or mechanical draughtsmen for duties in the supply department. H.N.C. in Electrical or Mechanical Engineering essential. Salary range £645 to £960 p.a. Local government conditions of service and superannuation scheme apply. Write Engineer and Manager, 25, Railway Street, Chatham, giving age and experience. 2942

REPRESENTATIVE, preferably with connection in electricity boards and some knowledge of distribution, required for Southern England, South Wales and Midlands. Good prospects for keen, energetic man. Apply—Ref. IHL, Bowthorpe Electric Co. Ltd., Crawley, Sussex (Tel. Crawley 28888). 2943

REPRESENTATIVES required London and Home Counties to sell a well-catalogued modern range of competitive tungsten lighting fittings to architects, wholesalers, contractors and large users. Salary, commission and expenses.—Box 2979.

REQUIRED by old-established firm of electrical engineers and contractors, a contracts engineer for permanent overseas position. Able to take charge of office at manager level. Must have experience of estimating, contract management, administration of U.K. and local labour. Applicants must produce evidence of their experience. Applicants should state completely their experience, salary expected and at least three references. Application should be marked private and confidential, ref. C.E.—Box 2920.

SALES lighting engineer required London S area. Contributory pension scheme; car provided. Apply—F. W. Thorpe Limited, Welby Road, Hall Green, Birmingham. 2929

SENIOR supervising engineer experienced estimating electrical installation contracts. Write Secretary, Rashleigh Phipps & Co. Ltd., Thackeray Street, Kensington Square, London, W.8, stating experience. 2937

TECHNICAL assistants, age 25-35, with special ability in mathematics, required to deal with design problems in the development, use and application of electric power cables, excluding pressure types, and associated technical correspondence. Also enquiries, chiefly impregnated paper and plastics. Minimum qualification H.N.C. (Elect.), but degree in electrical engineering preferred. Membership of I.E.E. an advantage. Write, stating qualifications, salary required, etc., to—Engineering Manager, Power Cables Dept., Associated Electrical Industries Ltd., Cable Division, Gravesend, Kent. 2977

WELL-known firm of control gear manufacturers require senior technical representative for London office. Please reply with full details of experience, qualifications and present salary to the Chief Electrical Engineer, Box 2980. Our own staff are aware of this vacancy.

APPOINTMENTS FILLED

Dissatisfaction having so often been expressed that unsuccessful applicants are left in ignorance of the fact that the position applied for has been filled, may we suggest that Advertisers notify us to that effect when they have arrived at a decision? We will then insert a notice free of charge under this heading.

SITUATIONS WANTED

A SENIOR project engineer, A.M.I.E.E. Development light and medium products. Instruments. Domestic. Testgear. New successful ideas and production improvements. Survey approx. Now.—Box 8369.

ASSISTANT manager seeks new position. 16 yrs.' contracting experience. Eastern Counties.—Box 8385.

CHIEF engineer, at present with British group in India, desires similar or electrical engineer's position in U.K. Returning Feb./Mar., 1962.—Box 8372.

ELECT. engr. (26), H.N.C., interested in A.C./D.C. rotating mach. design or development, seeks post London. Training received motors, transformers.—Box 8386.

ELECTRICIAN (41), ex Middle East, seeks further overseas employment, contracting, large and small installations, int. and external.—Box 8382.

ENERGETIC man, early thirties, only interested in a modern forward-thinking organisation in the electrical field, seeks a position as a sales manager. Qualifications, enthusiasm, ability. Grad. I.E.E.—Box 8379.

EST.-sup.-engrn., elec. contracting, exp. enquiry to final acct., desires progressive post, Sussex/Surrey/London area.—Box 8373.

REPRESENTATIVE, fully conversant with all types of electrical equipment, contracting or domestic, seeks position with manufacturer or wholesaler where initiative and hard work appreciated. Area Northants, Beds, Bucks, etc. 15 yrs.' trade experience.—Box 8384.

REPRESENTATIVE, 15 years electrical trade, desires change of position. Manufacturers' agency considered, London area and Surrey.—Box 8381.

TECH. sales engrn., industrial, commercial, lighting ftgs., all accessories. Elec. trade 25 years. Contacts London and S.E., wholesalers, contractors, users, arcts., consultants, govt. depts. Public school; car driver. Progressive post.—Box 8387.

TECHNICAL/electrical/mechanical engineer, A.M.I.E.E. Exp. executive, design, development, tech. sales advisory, production, management, in electromech. products, machines and switchgear, etc. Location pref. Essex/London.—Box 8388.

ARTICLES FOR SALE

A. C. DIBLEY & CO. LTD.

CANTERBURY HOUSE

CANTERBURY RD.

LONDON, N.W.6

MAIda Vale 8012

HAVE AVAILABLE FOR IMMEDIATE SALE

VARIABLE SPEED

A.C. COMMUTATOR MOTORS

400/415 VOLTS 3 PHASE 50c/s

One 30 H.P. 1100/220 R.P.M.

One 40 H.P. 1080/360 R.P.M.

One 40 H.P. 1440/420 R.P.M.

Two 55 H.P. 870/200 R.P.M.

One 60 H.P. 1650/250 R.P.M.

Two 20/60 H.P. 885/295 R.P.M.

One 75 H.P. 1650/250 R.P.M.

One 75 H.P. 920/230 R.P.M. 500 v.

Three 80 H.P. 760/190 R.P.M.

One "REGREMO" DRIVE

75 H.P. 1500/30 R.P.M.

2811

FOR SALE

TOOLS FOR FAN HEATER

COMPLETE set of Tools and Manufacturing Drawings for a proved silent, portable, wall fitting or floor, variable heating, one or two kilowatts, Electric Fan Heater or Cooler for summer.

Complies with B.S.1670 and B.S.1945.

The whole together with registered trade name. Principals only.—Box 2930.

HOUSE SERVICE METERS

200—240-v. A.C. or D.C., 10 amps. capacity, quarterly type, from 25s. each, plus 2s. 6d. carr.

UNIVERSAL ELECTRICAL CO.

221, City Road, London, E.C.1 37

A.C. and D.C. motors, generators, from stock.—Service Electric Co. Ltd., Honeyport Lane, Stanmore, Middx. (Edgware 5566/9). 91

A.A. ELECTRICAL Co. for A.C.-D.C. motors, switchgear, exhaust fans, hoists, reduction gears, new or reconditioned units.—CHI. 5105. 67, Rothschild Rd. London W.4. 57

A.C. and D.C. slotmeters and quarterlies. Reconditioned, guaranteed 2 years. Repairs and recalibrations.—Victor Electric Co., South View, Sweet Hill, Patcham, Brighton, Sussex. 8336

ALTERNATORS, 3-phase, all sizes in stock from 7 kVA up to 600 kVA.—Britannia Manufacturing Co. Ltd., Britannia Walk, London, N.1 (CLerkenwell 5512). 24

ALTERNATORS and generators, all types up to 150 kW.—Powerco Ltd., 312, York Road, London, S.W.18 (VAN. 5234). 151

BARGAINS in electric motors from A. Cooksley & Co. Ltd., 21/25, Tabernacle Street, London, E.C.2. Ring Monarch 3355. 50

CABLE, armoured, P.I.L.C., P.V.C., R.I.L.C., V.C.I.L.C. All sizes in stock at our London works. Cutting and delivery same day as order received. Priced stock lists.—Batt Electrical Co., 6, Dock St., London, E.1 (Tel. Royal 5905). 316

CIRCUIT-breakers, various sizes in stock, A.C. and D.C., 200 amperes up to 2,000 amperes. Also dynamo and alternator switchboards.—Britannia Manufacturing Co. Ltd., 22/26, Britannia Walk, London, N.1. 26

CONVERTERS, motor-alternators, motor-generators, frequency changers, etc. All types up to 100 kW.—Powerco Ltd., 312, York Rd., London, S.W.18 (VAN. 5234). 150

CRANE motors. Direct current, series wound or compound wound, all voltages. We have large stocks.—Britannia Manufacturing Co. Ltd., 22/26, Britannia Walk, London, N.1. 22

DIESEL generating sets, all sizes to 500 kW. Britannia Mfg. Co. Ltd., Britannia Walk, London, N.1. 16

ELECTRIC motors, dynamos, alternators and motor generator sets of all sizes. We hold one of the largest stocks in England. New and reconditioned, with 12 months' guarantee.—Britannia Manufacturing Co. Ltd., Britannia Walk, London, N.1 (Clerkenwell 5512, 3 lines); also Works and Stores, Chobham, Surrey. 20

ELECTRIC motors, generators, motor generator sets, transformers, switchgear, etc., large comprehensive stock, overhauled and guaranteed. Copy of our Register, "Electrical Surplus," containing thousands of items of electrical plant, sent on request.—R. F. Winder Ltd., Belgrave Electrical Works, Leeds, 2. 54

FLAMEPROOF squirrel cage motors. Two 30 h.p., 400/440/3/50 at 2,900 r.p.m. Also two 37.5 h.p. at 1,480 r.p.m. Flameproof star-delta starters also available. Overhauled. Guaranteed.—Fyfe, Wilson & Co. Ltd., Station Works, Bishop's Stortford. 162

FLUORESCENT tubes reconditioned and guaranteed with a life as new for 7s. 6d. each. Free collection and delivery in Lancs and Yorks. We are also manufacturers of top quality fluorescent fittings, trunking systems, control gear and new fluorescent tubes. Generous discounts available.—Anglo-American Electrical Company, Olive Street, Bury (Telephone, Bolton 27251). 212

FOR sale, good unused and used machinery including electric motors, A.C. and D.C. dynamos, alternators, transformers, diesel and steam electric generating sets, mains failure sets, motor generator and Ward Leonard sets, switchgear, compressors, fans, capacitors, etc.—Fyfe, Wilson & Co. Ltd., Station Works, Bishop's Stortford, Herts (Tel. B.S. 1000/1). 161

FOR sale, J. T. Holmes Castle D.C. motor, cont. rating, 10.7/30 b.h.p., 440 volts, 22/61 amps., 300/840 r.p.m., with Westinghouse rectifier, 400/440 volts input, 400/440 volts, 35 amps. output. Complete with transformer and British Klockner regeneration safety units. Armature, rewound and new bearings fitted 3 months ago. Rectifier equipment new 1960. Also Ignic auto speed control panel, new 1960. Any reasonable offer accepted.—Telephone Hop (London) 3211, Ext. 30. 2834

FRACTIONAL h.p. motors down to 1 r.p.m. week. 250 Hoover motors always in stock. 11 different ratios of David Brown gear boxes always available means a motorised unit from stock. From—Jearys, 132, East Road, London, N.1. 126

GENERATING sets, portable or stationary, new and reconditioned, 1 to 100 kW, A.C. and D.C.—Powerco Ltd., 312, York Road, London, S.W.18 (VAN. 5234). 148

INSULATING varnish, clear, Minerva No. 1720, £10 per 40-gal. drum.—Lowton Metals Ltd., Sandy Lane, Lowton St. Mary's, Leigh, Lancs. (Tel. 71441/2). 93

KARDEX, Roneodex and Shannovue cabinets, as new.—F. H. Jolly & Co. Ltd., 289, King St., London, W.6 (RIV. 5381). 202

METAL rectifiers, full wave bridge, 250 v. A.C., giving 230 v. D.C., 8 amps. Brand new. £4 18s. 6d.—Kingston Electrical Supplies, 134, London Rd., Kingston (KIN. 7534). 8383

MOTOR generator sets and converters, all sizes and voltages from $\frac{1}{2}$ kW up to 500 kW in stock.—Britannia Manufacturing Co. Ltd., 22-26, Britannia Walk, City Road, London, N.1 (Tel. Clerkenwell 5512, 5513 & 5514). 12

MOTORS and control gear, huge stocks all types, $\frac{1}{2}$ to 200 h.p.—Ramsbottom & Co. Ltd., Elec. Engineers, Keighley (5444/7). 70

NAMEPLATES, engraving, diesinking, stencils.—Stilwell & Sons Ltd., 153, Far Gosford Street, Coventry. 108

NEW C.P. motors for sale. All 400/440 volts, 3-phase, 50 cycles. 4 off 1 h.p., 940 r.p.m.; 8 off 2 h.p., 1,430 r.p.m.; 7 off 3 h.p., 1,430 r.p.m.—Cliffe & Co. Ltd., Longroyd Bridge, Huddersfield. 2947

PHASE converters, single to three-phase, several sizes in stock up to 90 h.p., 3-phase loading.—Britannia Mfg. Co. Ltd., Britannia Walk, London, N.1. 29

PLATING dynamos and motor generator sets, various sizes from 500 amps. up to 2,000 amps., with A.C. and D.C. motors.—Britannia Manufacturing Co. Ltd., 22/26, Britannia Walk, London, N.1. 15

POLYPHASE kilowatt hour meters. Available from stock.—Universal Electrical, 221, City Road, London, E.C.1. 40

PREPAYMENT is. slot house service meters.—Universal Electrical, 217-221, City Road, London, E.C.1. 36

PURLEY chokes and ballasts. Our 80-w. tapped h.p.f. ballast with starter switch-holder incorporated is proving itself the most popular unit. Suitable for most fittings, 57s. 6d. each subject.—F. W. Blanshard Ltd. (Dept. ER), Purley, Surrey (Uplands 4818/9). 52

ROTARY converters in stock, all sizes; enquiries invited.—Universal Electrical, 221, City Road, London, E.C.1. 34

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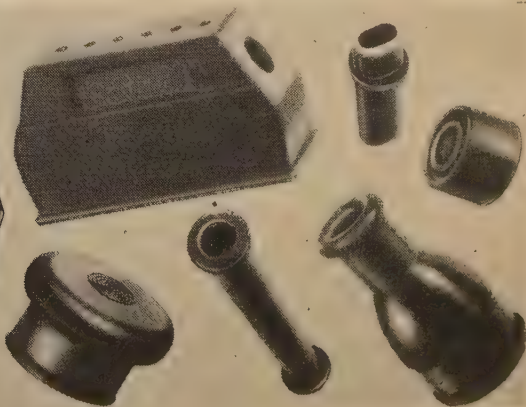
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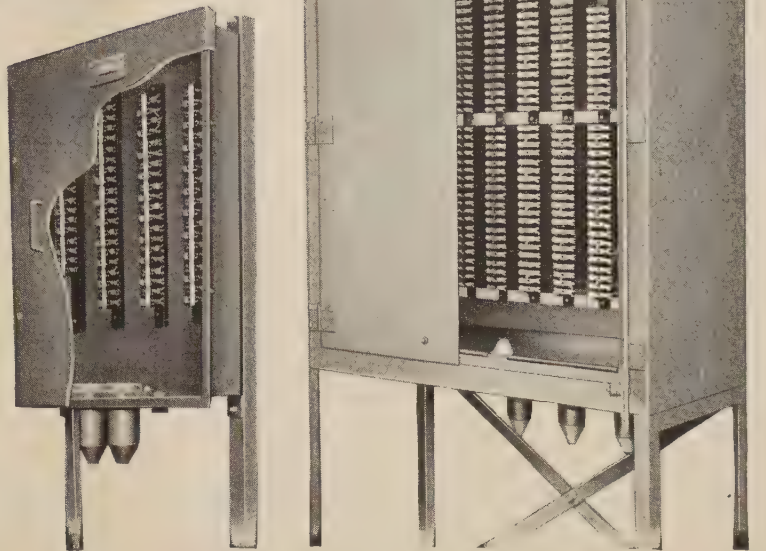
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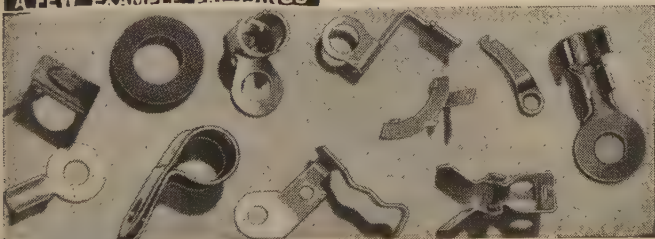
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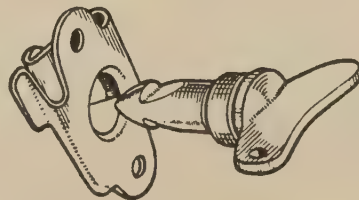
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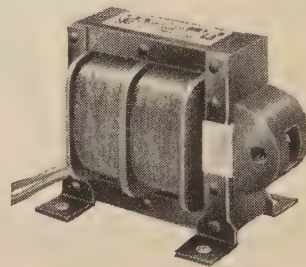
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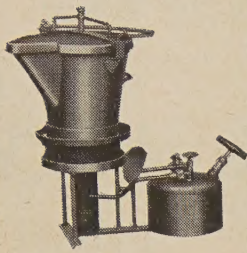
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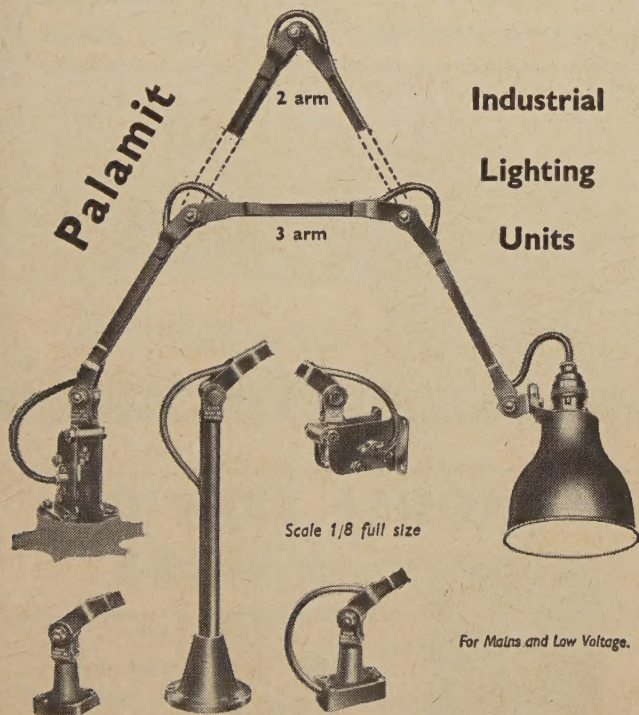
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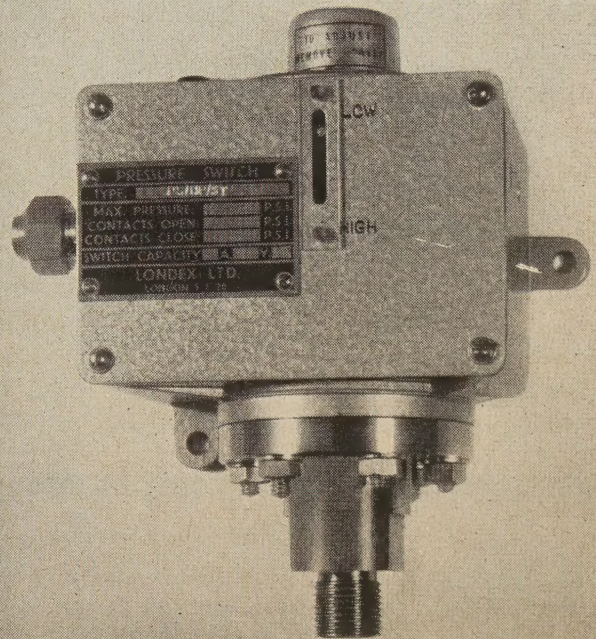
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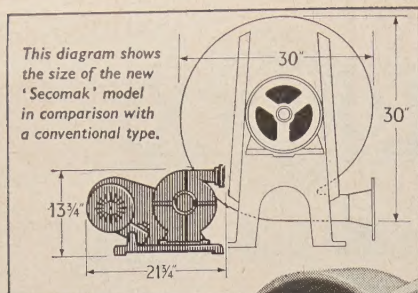
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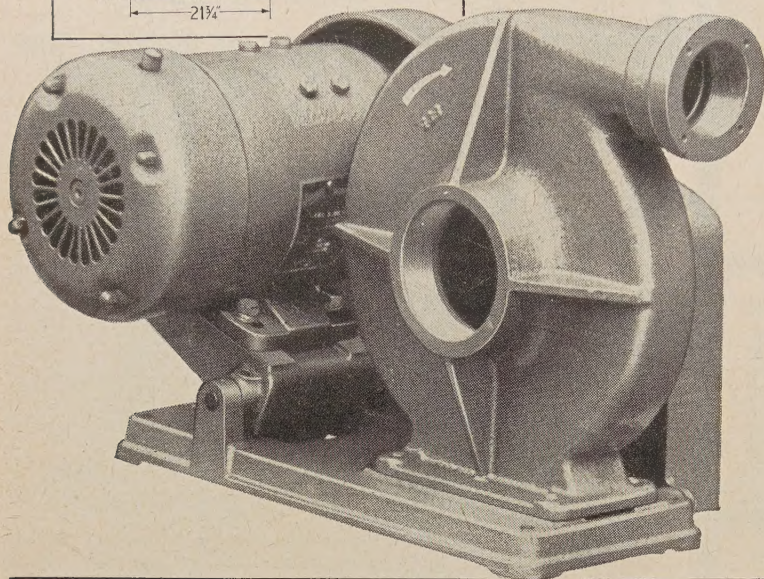
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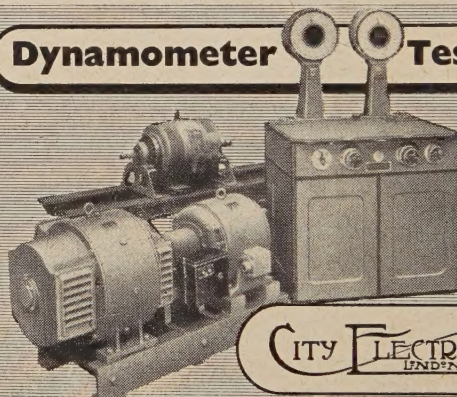
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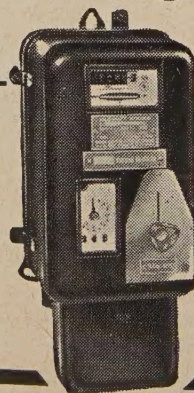
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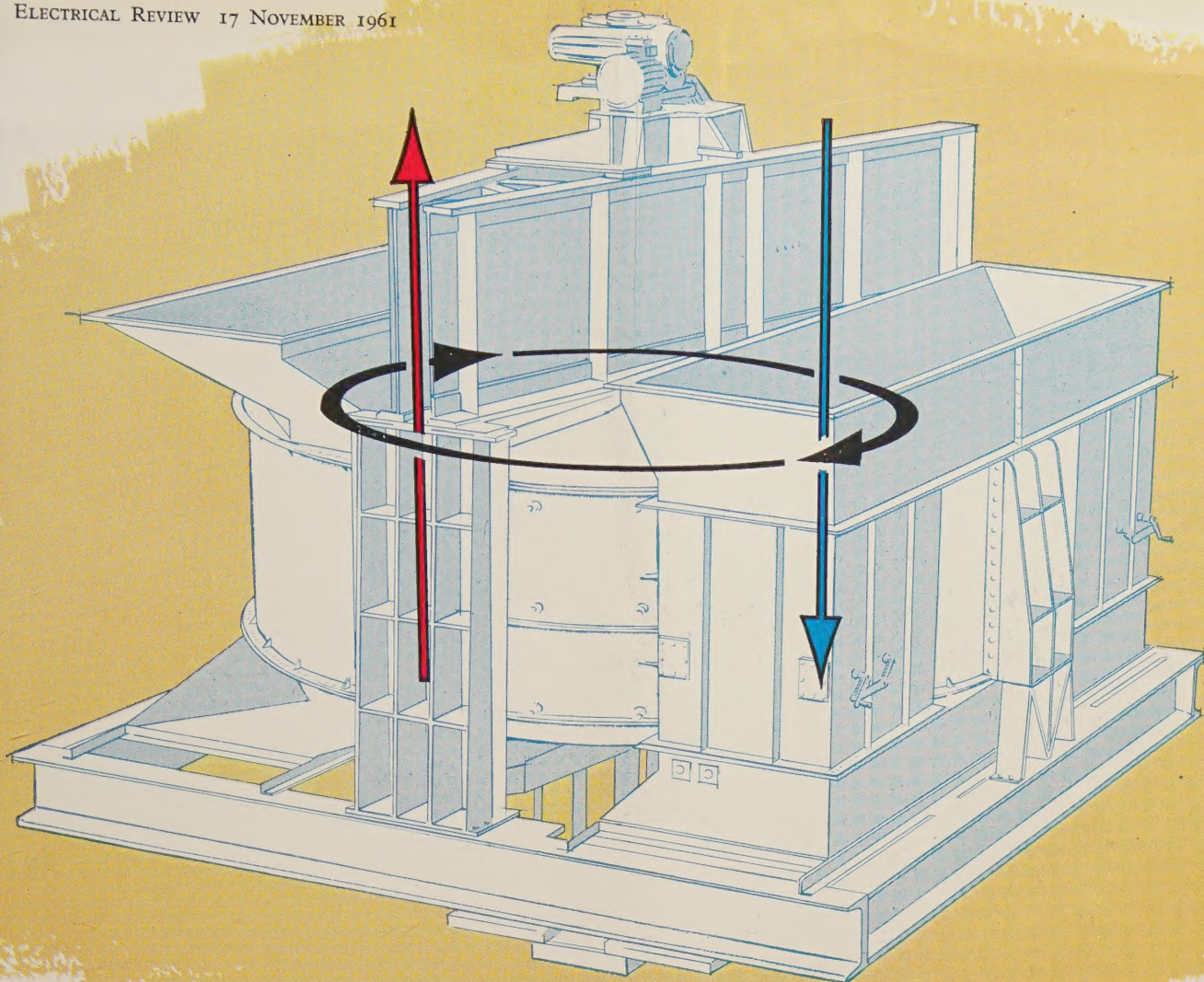
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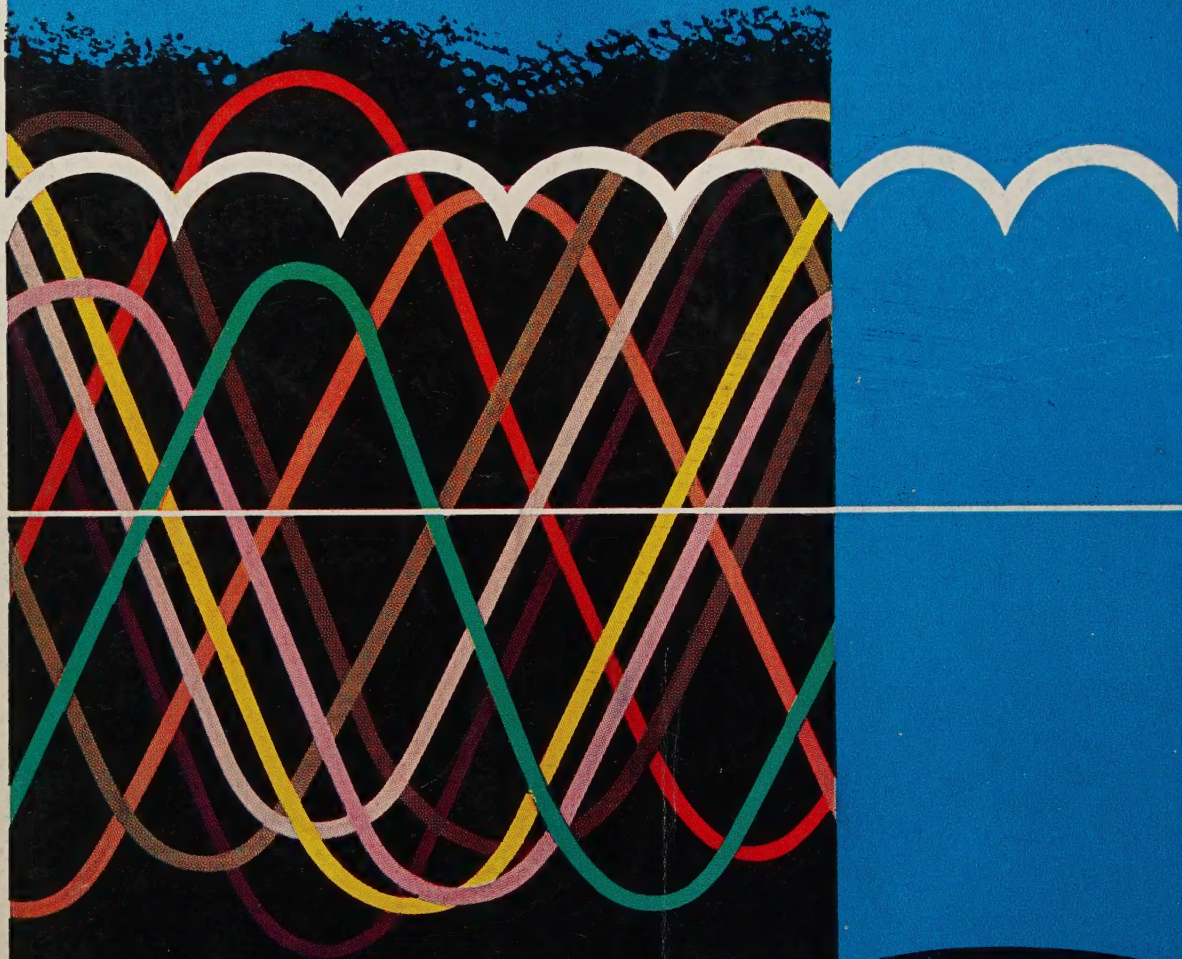
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